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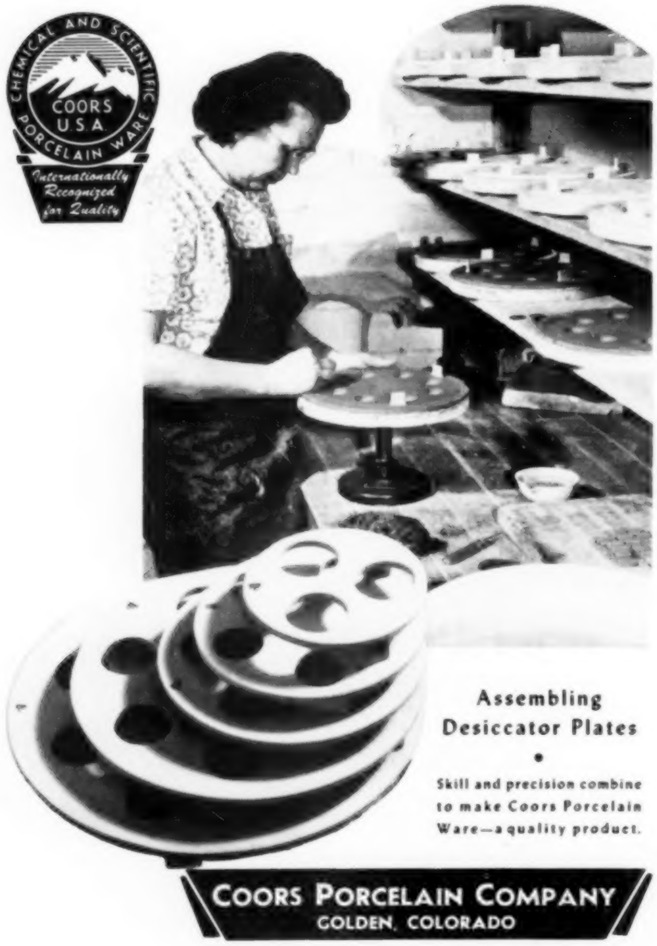
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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

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The Role of Comets in Modern Astronomy

• By Joseph Ashbrook
DEPARTMENT OF ASTRONOMY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

What are comets? Are they members of our own solar system or visitors from interstellar space? Of what are they composed? What is their relation to meteors? What causes their decay and disappearance?

These and a number of other questions are discussed by a well known scientist in this brief account of a natural phenomenon that is not so rare as is commonly believed.

Here is valuable teaching and background material for the teacher of general science.

A large portion of the work of the astronomical observer consists of photographing the sky, for his telescope used as a camera provides a permanent record of stars and nebulae too faint to be shown visually through the same instrument. While examining his negative, the astronomer will sometimes find, among the myriads of round black star images, a short fuzzy trail, looking much like a gray caterpillar. This is a small comet, whose motion relative to the stars during the hour or so of exposure has spread out its image into a diffuse band. This is how the majority of comets are discovered today. Many of the brighter comets are found by amateurs who carefully search the sky visually with small telescopes, and the rare comets which suddenly appear as conspicious objects to the naked eye are sometimes first reported by persons who are not astronomers at all.

The discovery of a comet is no longer a rare event. In 1948, a total of 14 were discovered, and in 1947, no fewer than 22 were under observation. Yet the majority of comets go their way unobserved, since a small comet has little chance of detection, unless it either passes very close to the earth, or is near enough to the sun to be strongly illuminated by it. (Even Halley's comet is so faint at great distances from the sun that it can be seen only during less than two years out of the 76 which it requires to complete a revolution around the sun.) Clearly our discovery lists are very incomplete, and the total number of comets within the solar system must be very great indeed.

The appearance and brightness of a comet will undergo striking changes as it approaches the sun. At great distances from the sun, a comet ordinarily appears as a faint nebulous patch of light, known as the coma, in which is usually imbedded a star-like nucleus. As the comet nears the sun it brightens and a short stubby tail will appear. This grows steadily in length, almost always pointing directly away from the sun. The great comet of 1843, which was bright enough to be seen in full daylight, had a tail which became nearly 200,000,000 miles long, which is the greatest recorded length. As the comet recedes from the sun, this sequence of changes occurs in reverse order. No two comets share the same development. A small comet may never grow a tail, and the heads of conspicuous comets, like Donati's in 1858, have sometimes shown beautiful and intricate luminous hoods and jets. Abnormalities are frequent; the comet of 1744 had six tails; Biela's comet was observed to divide in two; and several comets have had twin nuclei. Even the same comet may change so much that a periodic comet cannot be recognized by its appearance alone on successive returns, but must be identified by the shape of its orbit.

Unlike the planets, which are built up almost entirely of solid matter, the comets are extremely tenuous bodies. Stars shine undimmed through the coma and tail of a comet. The great comet of 1882 and Halley's comet in 1910 both passed between the earth and the sun; in each case the comet could be seen up to the very edge of the sun, when it vanished. Clearly the amount of matter in a comet must be very small, which is further borne out by the fact that the gravitational attraction of a comet has never produced any observable change in the orbits of the planets. Moreover, the earth passed through the tails of comets in 1861 and 1910; the ignorant were terrified by the predictions, but the danger was as little as a spider web offers to a charging rhinoceros.

An important problem is whether all the comets are members of our own system, or whether some are visitors from interstellar space. This question is equivalent to whether the orbits of the comets are all elliptical and hence closed, or whether some are parabolic or hyperbolic, and hence open. There are about 50 periodic comets which have been observed to return, but the majority of the comets move in very elongated orbits which are difficult to classify. The Danish astronomer Elis Strömgren and his coworkers made a study of 22 comets whose orbits appeared to be hyperbolae. In each case, the attractions of the planets which warp the shape of the orbit were calculated, and the motion of the comet was traced backwards for years until the comet was so distant that the disturbing effect of the planets was negligible. And in every instance, the original orbit of the comet was found to be an ellipse. Accordingly it seems very likely that all observed comets are members of the solar system, and are not interlopers from outside. This means that the comets were born inside the solar system, and that any acceptable theory of the origin of the solar system must account for the origin of the comets.

Insight into the nature of the comets is provided by their connection with meteors. The meteors are small particles, ranging in size from grains of dust to

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A Lesson on the Understanding of Science

• **By Mel Gorman, Ph.D.,** *(Stanford University)*
DEPARTMENT OF CHEMISTRY, UNIVERSITY OF SAN FRANCISCO, SAN FRANCISCO, CALIFORNIA

Many observers believe that science is not being assimilated into our culture to the extent it should be.

At Harvard, Colgate, and other schools attention is being given to the discovery of new approaches to science teaching that will provide time and place for the logical development of scientific thinking, and by the use of case histories, impart a better understanding of the ways in which science develops.

Dr. Gorman believes that the concept of isotopes can well be utilized as a case history. Here he describes his plan for doing it.

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For a number of decades it has been fashionable to refer to our times as the age of science. During the last few years, due to the demonstrated power of atomic fission for both destructive and peaceful purposes, this viewpoint has been emphasized and particularized by referring to contemporary times as the era of atomic energy. In such an environment of scientific achievement it would seem heretical to raise any question concerning the success of our colleges and universities in their effort to impart a fundamental understanding of science to their students. Yet, there has been growing the feeling that the various science curricula have not been successful in this regard, and some eminent science educators have been outspoken in their vigorous criticism of current types of science courses as proper vehicles for teaching the methods and development of the sciences.

Dean Sidney French of Colgate University, stressing the need for a new approach to science teaching,[1] points out in no uncertain terms that the orthodox basic science courses, consisting as they do of facts, principles, and formulas necessary for professional training, allow no time or place for logical development of scientific thought, or for an explanation of the historical heritage so necessary for understanding the growth of science. He believes also that the survey courses suffer the same defects. He recommends for non-scientists a course of important historical topics in science, so that such students may study how early problems arose, how they were attacked, and the significance of their solution to society. Dean French maintains that in such a course a real fundamental understanding of science can be taught, and then applied to scientific problems of our times.

The views of Dean French are shared in large part by President Conant of Harvard In his book, *On Understanding Science*,[2] Conant points out that in spite of the fruits of science so much in evidence about us, science has not been assimilated into our culture. He argues that this assimilation will be realized only when a widespread understanding of science is acquired, and he proposes to implement the approach to this end by college courses dealing with case histories in scientific development. Among the objectives would be the difficulties attending each scientific advance — the false starts, mistakes of observation and generalization, and the human obstacles of pride and prejudice; the importance of new experimental techniques, the interplay between experiment and theory, and the modification or displacement of one theory by another would be emphasized. The case histories chosen would have to meet the requirements of involving relatively few facts, and illustrating simple principles. Conant believes that students completing such a course will be more capable of assisting in the assimilation of science into a cultural pattern consistent with the ideals of a democracy in this atomic age.

There are many science teachers who would like to see the suggested courses instituted at once. But such additions to college curricula are usually a long time in being effected. In the meantime, what should be the attitude or the procedure of a teacher of one of the basic courses for science majors or of survey courses, who subscribes strongly to the ideas expressed by French and Conant? Should he continue to say that there are so many facts and principles to cover, that none of the objectives of a case history course can be treated in the conventional courses; or should he resolve to omit a few descriptive facts in favor of presenting the historical approach of at least some topics in his course, and thus make a beginning in the task of providing his students with some understanding of the development of science? This paper attempts an affirmative answer, by showing that the concept of isotopes can be utilized as a case history in the development of chemistry. This topic meets many of the requirements set by Conant, and moreover has the advantage of being short enough so as not to disturb unduly the content of conventional first year chemistry courses.

Any attempt to present the story of isotopes must begin with a consideration of the address of Sir William Crookes to the Chemical Section of the British Association in 1886.[3] The most frequently quoted passage in this paper of scientific predictions is the following: "I conceive, therefore, that when we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on." When one glances back from the present vantage point of scientific knowledge, assembled with the aid of a full study of radioactivity, precision mass spectrographs, x-rays, and a highly developed theory of atomic and nuclear structure, it seems

impossible that such a prediction could be anything more than a lucky guess. Actually, this prophecy was the result of a brilliant line of reasoning and imagination, but a real understanding of its origin cannot be achieved without a knowledge of the intellectual milieu from which it emerged.

Crookes lived in an age of speculative ferment in the fields of science. In biology, Darwin's theory gave rise to a wave of controversy which still possesses some momentum. In the realm of inorganic matter, the age old problem of the nature of the elements was being explored in the light of Dalton's atomic theory proposed in 1803. Philosphers, chemists, and physicists were engaged in discussing their ideas of the nature of matter, and the representatives of these different disciplines were familiar with the methods and content of the others. Since the body of scientific facts and principles was small, there was not present that high degree of specialization which in modern times so often isolates scientists in different fields of interest. Furthermore, scientists were conversant with their philosophical contemporaries, and respected the fact that philosophy could contribute to the unfolding of knowledge of the constitution of matter.

This whole state of intellectual activity is mirrored very completely in Crookes' address, which today is regarded as an excellent example of the history of scientific thought. After some introductory remarks, Crookes challenges his listeners with the question, "What are the elements?" He goes on to point out that the current definitions of elements in textbooks of that time were unsatisfactory, because they clung to the Daltonian concept that the elements were ultimate and simple substances. Then he quotes eminent chemists, physicists, astronomers, and philosophers to show the contemporary growth of the notion that, contrary to Dalton's idea, elements were really of complex nature. Crookes arrays a formidable set of arguments — philosophical, geological, spectroscopic, and chemical—to support such a view, and then outlines his own hypothesis to explain it.

Borrowing an ancient idea, he proposed that the then known elements came into existence by a process of chemical evolution from *protyle*, "the original primal matter existing before the evolution of the chemical elements" in pre-geological ages at such high temperature "that the chemical atoms could not yet have been formed, being still far above their dissociation point." In the process of cooling, the element of simplest structure and lowest atomic weight is formed first, and so on in order for heavier and more complex elements. According to Crookes the *protyle* was endowed with the ability to form atoms of different weight of the same element. This is the basis for his statement about calcium which was quoted above. Next he summarizes his spectroscopic experiments with fractionally precipitated yttrium compounds, and his interpretations of the observations: "Excessive and systematic fractionation has acted the part of a chemical 'sorting Demon,' distributing the atoms of yttrium into several groups, with certainly different phosphorescent spectra, and presumably different atomic weights, though all of these groups behave alike from the usual chemical point of view. . . . And as this is the case with one element, it is probably so in a greater or less degree with all."

Here, then, was a modification of Dalton's theory in the form of an acceptable explanation for the existence of fractional atomic weights. However, after a few years this explanation was no longer tenable, because improved methods of rare earth separation proved that the various spectra observed by Crookes actually were due to the presence of rare earths and not yttrium alone. Dalton's theory remained supreme, but once again the puzzle of fractional atomic weights confronted scientists.

Some insights to the true understanding of science are provided by this chapter in the development of the concept of the nature of atoms. First and foremost, there is the necessity of being familiar with the scientific thought of the times in which the advance is made. Without such knowledge, the full impact of the achievement cannot be visualized. Secondly, the difficulty of experimentation, in this case rare earth elimination, was the cause of an unjustified conclusion. This fact can be used as an example to emphasize the pitfalls into which even the most capable investigators can fall when they are engaged in pushing back the frontiers of science. Thirdly, this is an illustration of the persistence of a simple theory, even after the accumulation of many new facts and the discovery of new and complicated phenomena. Dalton's immutable and identical atoms of a given element remained that way for almost a century, notwithstanding the spectacular expansion of all branches of chemistry.

The first experimental indication of the correctness of Crookes' prediction was an inevitable result of the epoch making discovery of radioactivity. By 1915, overwhelming evidence from atomic weight determinations of lead from different geological sources led to the acceptance of the existence of isotopism among the heavier elements. In the meantime, Soddy's suggestion in 1910[4] that the lighter elements might exist as atoms of different weight did not receive immediate acceptance. Whereas radioactive elements were so new and unusual that anything might be expected of them, such was not the case with the ordinary elements. For instance, the constancy of atomic weights among these elements, regardless of geological source, remained an unshaken fact.

Proof of isotopism among the elements generally was to come only with the use of a new technique, positive ray analysis. As early as 1907 Sir J. J. Thomson reported experiments in which he obtained the parabolas of hydrogen and helium. As time went on he improved his apparatus so that greater resolving power resulted. In 1912, an examination of the results with neon, besides indicating the expected mass of 20, also showed the presence of mass 22. Although Thomson suggested that the latter might belong to a new element very

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Science in Weather Forecasting

• By Ivan Ray Tannehill, B.S., (Denison University)
HEAD, DIVISION OF SYNOPTIC REPORTS AND FORECASTS, UNITED STATES WEATHER BUREAU; PRESIDENT, COMMISSION FOR SYNOPTIC WEATHER INFORMATION, INTERNATIONAL METEOROLOGICAL ORGANIZATION, WASHINGTON, D. C.

Weather forecasting, once an art depending upon the experience and skill of the individual, is slowly changing to a science with an increasing amount of the work being done by numerical processes.

You may read in this article how barometers, balloons, weather maps, radar, and means of rapid communication help forecast tomorrow's weather.

The rheumatic foot as a weather indicator is outmoded.

LUCIEN VIDIE who invented the aneroid barometer in 1843. His device is used in pressure-recording barographs throughout the world.

One event stands out in the history of meteorology. In 1643 an Italian physicist, Evangelista Torricelli, discovered the principle of the barometer as a device to measure the pressure of the atmosphere. His discovery did more for weather forecasting than any other event in history. Although there have been many developments since that time, the variations in the pressure of the atmosphere continue to be the chief reliance of the modern weather forecaster.

To understand the significance of Torricelli's discovery, and the resultant improvements in weather forecasting, it is necessary to consider the art as it existed prior to the seventeenth century. Aristotle and his predecessors had some useful ideas on meteorology. The work of Aristotle stood as the standard text for nearly two thousand years. During that time, there was little real progress in weather forecasting.

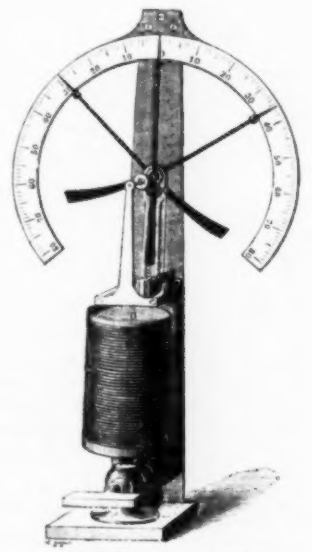
Before the discovery of the barometer, there were weather sayings, or proverbs, some of which had a scientific basis, while others were merely jingles. Weather lore is found in the writing of poets, philosophers, and others, and much of it survives to this day.

"Above the rest, the sun who never lies,
Foretells the change of weather in the skies."
—*Virgil.*

"A red morn that ever yet betokened
Wreck to the seaman, tempest to the field,
Sorrow to shepherds, woe unto the birds,
Gusts and foul flaws to herdsmen and to herds."
—*Shakespeare.*

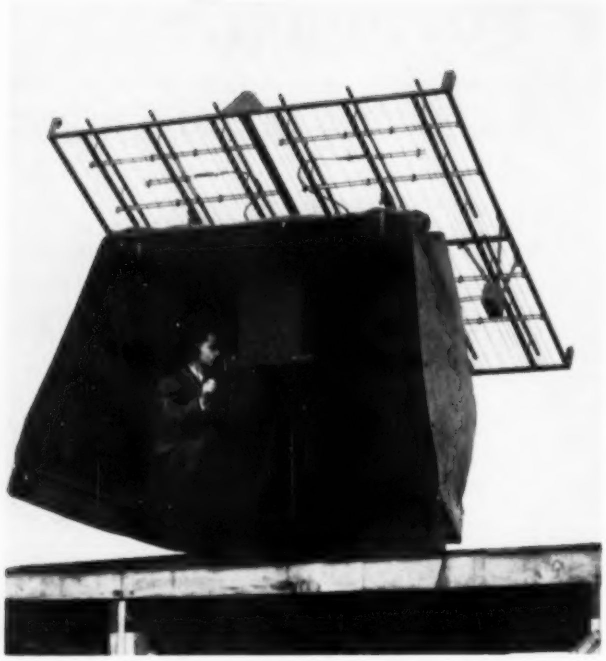
Soon after 1643 it was discovered that the rise and fall of the barometer give advance indications of changes in the weather. It was but a small step to put inscriptions on the instrument: "Stormy," "Rain," "Change," "Fair," etc., so that the novice could get crude weather indications in the simplest manner. Two hundred years later, a Frenchman, Lucien Vidie (1843) contrived a gadget to operate from a vacuum cup, actuating a hand travelling around a dial to show pressure changes. This evolved into the well-known aneroid barometer widely used today. Its great advantage is portability; some of the early barometers were enormous and immovable.

Thus, for thousands of years weather forecasting depended on signs—some fancied connection between the coming weather and the appearance of the sky, the behavior of animals, and such,—a confusing mixture of superstition and shrewd observation. Even the indications of the barometer were poorly correlated with the coming weather. Until the 19th century, no one knew for sure that weather moves from place to place. A century after Torricelli's time, Benjamin Franklin suspected that storms in eastern United States travel from southwest to northeast and wrote on the subject, but it remained for a German named Heinrich Brandes (1820) to gather reports by mail and draw the first maps of the weather. This threw a flood of light on the problems that had puzzled the forecasters. The maps showed clearly that weather moves, and that the arrival of storms could be predicted, but mail was too slow for the reports to be used in weather forecasting.



VIDIE'S ORIGINAL ANEROID BAROMETER.

Practical meteorology has always been "handcuffed" to communications. The forecaster can't see very far ahead with any accuracy, so his reports and forecasts must be communicated quickly. Immediately after the invention of the telegraph, it was apparent that weather reports could be gathered



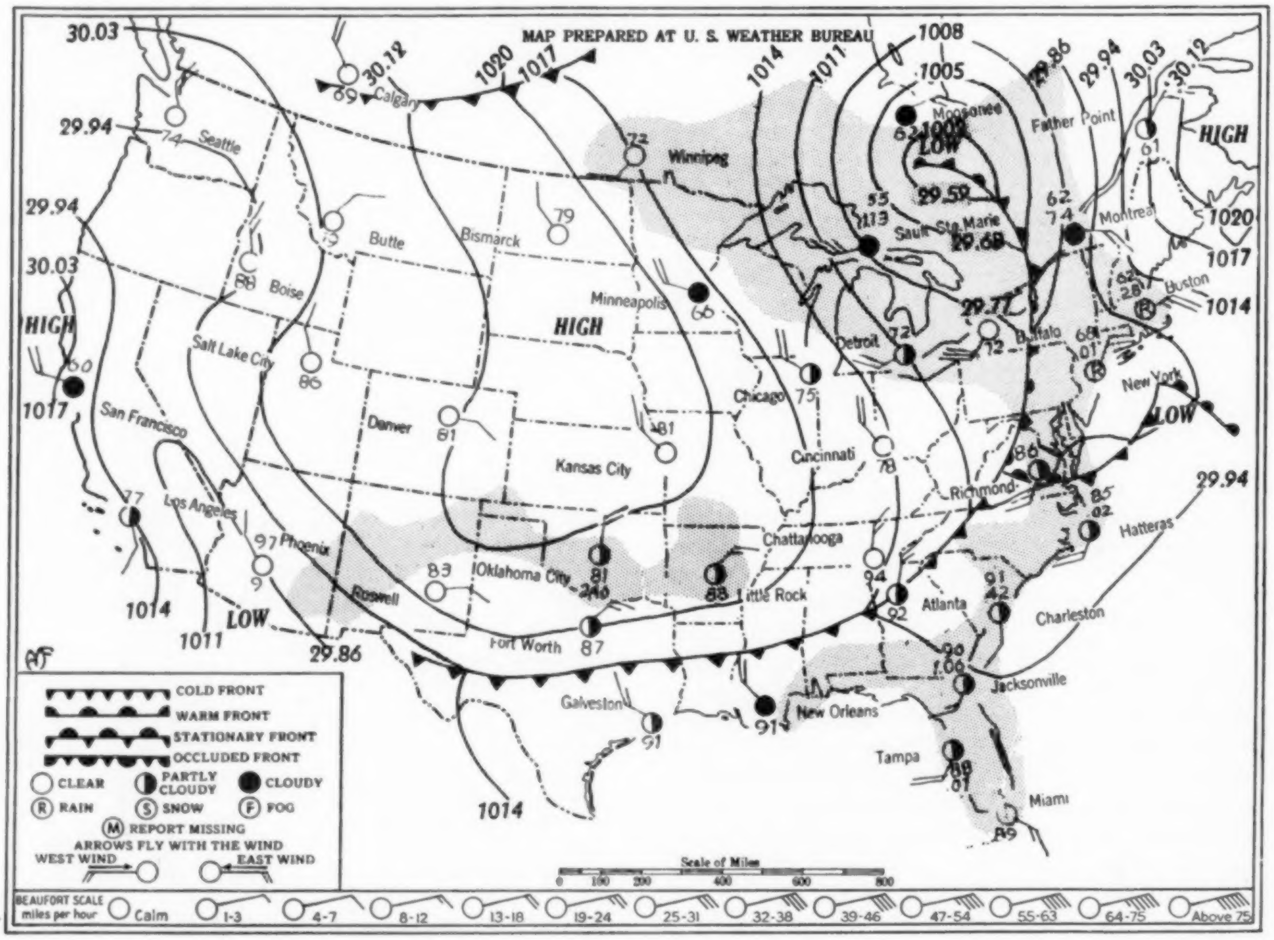
By Radar the forecaster sees the storms and rain areas which are shown geographically on his weather map.

and the forecasts sent out with impressive speed. As one result, national weather forecasting services began cropping up here and there in the civilized world. The Weather Bureau in the United States began in the U. S. Signal Corps in 1870.

Thus the forecaster's weather map from telegraph reports is only about one hundred years old. At first, of course, the weather map was crude, with only a few brief weather reports entered in simple form. As experience grew and weather forecasts became more accurate, the reports contained more information and there were more and more reporting stations. In these years, weather forecasting earned a place in the professions as an art depending largely on the skill of the individual forecaster in interpreting the indications of the weather map—the development and travel of weather. As time went on, there was an insistent demand for greater accuracy and man began to look to the upper atmosphere for an explanation of his forecast failures, first by extensive use of cloud observations, and then by sending up balloons. After the barometer, the weather map and the balloon were the most important aids except fast communications.

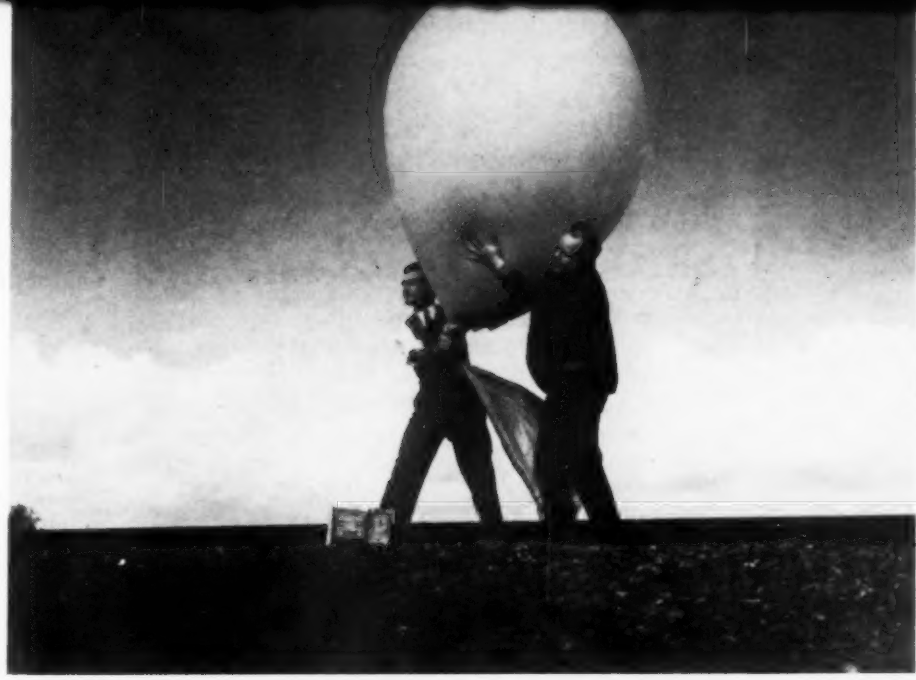
Radio brought weather reports from ships at sea and

A Simple Weather Map published in newspapers. The forecaster's map contains too many details for reproduction here.



thus the forecaster's maps extended out over the oceans. Miniature radio stations with meteorological instruments were attached to balloons to send weather by radio signals and thus speedier reports of the upper air came to the forecaster's map. Air traffic financed and pressured the meteorologist to new endeavors. Planes had to move in and out of airports on hourly weather reports and forecasts, and as flying distances increased, the problem became more difficult.

It is only in these last two or three decades that weather forecasting has shown definite signs of developing into an exact science. The forecaster is now obtaining by numerical process some of the information he uses to determine the structure of the atmosphere, the movements of weather systems, and broad-scale studies of the circulation of air in the Northern Hemisphere. Meteorology is now at the threshold of real scientific achievement.



THE BALLOON carries radio and meteorological instruments which send temperature, pressure and humidity signals to the ground station.

Today, weather forecasters in the United States have sufficient data in the daily reports of the weather elements at the earth's surface and in the upper air to make a beginning at employing quantitative methods. Thus, while forecasting has been remarkably successful as an art depending on the experience and skill of the individual, it is slowly changing to a science with an increasing amount of the work being done by numerical process.

Especially during and after World War II, science has entered into weather forecasting on a broadening front. By radar the forecaster can actually see the rain areas and the storm characteristics which he portrays graphically on his maps. Aircraft are dispatched into hurricanes, carrying sensitive instruments. The crews include trained observers who send by radio the essential information formerly obtained by estimate from scattered data at the earth's surface. Twice daily, balloons rise from a network of stations in North America, carrying aloft the radio-weather instruments which transmit signals to the ground station. These signals are converted into accurate pressure, temperature and humidity data at various selected levels. From these signals, the forecaster constructs maps and cross sections, thus obtaining a measure of the three-dimensional structure of the atmosphere. Rapid exchange of the data with other countries enables him to extend the process around the Northern Hemisphere.

The problem of dealing with the complex structure and circulation of the atmosphere is one of the most difficult in any science. The conditions in the free air cannot be set up satisfactorily in laboratory experiments. The meteorologist has been obliged to deal with his problem as he finds it, on a broad scale, with the innumerable effects of mountains, valleys, continents, oceans, plains, forests, cultivated land, the steaming tropics, polar ice and snow, the inequalities of land and water in the two hemispheres, the little known variations in the sun's radiation as it reaches the atmosphere, and countless other influences large and small. The fascination of working in comparatively unexplored scientific fields holds meteorologists to their daily struggle with these entangled complexities, and little by little the science advances. The economic benefits repay these efforts a thousand fold, for weather moulds the lives and works of men.

"What is it moulds the life of man?
The weather.
What makes some black and others tan?
The weather.
What makes the Zulu live in trees
and Congo natives dress in leaves
While others go in furs and freeze?
The weather."—*Humphreys.* ●

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"Those who believe that Hiroshima was a very special event in human history are impressed with the weighty obligations of educators to help unravel some of the horrible and fascinating problems newly created. Since those problems are both technical and intellectual, educators find that circumstances have given them a virtual monopoly of knowledge of this new phase of human affairs. They therefore believe that in a democracy they must share that knowledge without reservation with those who must make the basic decisions of the future. It is they who are taking the pains to revamp old courses, start new ones, speak and write and broadcast for popular consumption, and do whatever else they can to give and gain wisdom on what they consider to be history's gravest crisis."

CLAUDE E. HAWLEY
Higher Education

A.A.A.S.

The American Association for the Advancement of Science

• By J. M. Hutzel
ADMINISTRATIVE ASSOCIATE A.A.A.S., WASHINGTON, D. C.

An association that gains 1,000 members a month has vitality. A federation of 209 scientific societies with a combined membership of a half-million persons has strength and influence. An association that has served American scientists well for 100 years has stability. The A. A. A. S. has all these and more.

Teachers of science should be among the first to recognize the desirability of belonging to this Association and of participating in its affairs.

The A. A. A. S. may be addressed at 1515 Massachusetts Avenue, N. W., Washington, D. C., for application blanks and information concerning membership.

The conclusion of this past year marked the end of the first hundred years in the history of the American Association for the Advancement of Science, the oldest general, national scientific society on the American continent. Known colloquially as the "Triple A. S.," the Association has kept faith with its founders for a century, and has fulfilled with steadily increasing success the high purposes for which it was established. Today it is a growing federation of 209 affiliated scientific societies whose combined membership exceeds half a million persons. In a real sense the Association is, because of its size and general representation, the sounding board of American scientific opinion.

The Association was first organized with two sections, General Physics and Natural History. In the succeeding years the number of sections has increased and now includes Mathematics, Physics, Chemistry, Astronomy, Geology and Geography, Zoology, Botany, Anthropology, Psychology, Social and Economic Sciences, History and Philosophy of Science, Engineering, Medical Sciences (Medicine, Dentistry, Pharmacy), Agriculture, and Education. Most of the affiliated societies had their orgins in these sections, and as a rule, until about 1920, met with the Association and participated in its programs. As the memberships increased, it became necessary for many of the larger societies to meet separately. Some of the societies have grown to such an extent that there are now only a few cities with sufficient housing and session room accomodations to fill their minimum meeting requirements.

The objectives of the Association adopted at its first meeting in September, 1848, were, "by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of the United States; to give a stronger and more general impulse, and more systematic direction to scientific research, and to procure for the labours of scientific men, increased facilities and wider usefulness." The present day objectives of the Association are much the same. They have been extended to include new responsibilities imposed by the growing role science is playing in the advancement of civilization. Specifically, they are to "further the work of scientists, to facilitate cooperation among them, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress."

To carry out these objectives, the Association, in cooperation with its affiliated societies, organizes and conducts meetings and conferences for those interested in the various branches of science and education; edits and publishes two journals, *Science* and *The Scientific Monthly;* publishes and distributes technical symposium volumes; administers awards for scientific achievements and excellence in press and magazine reporting; and carries on other activities authorized by the Council, which is the governing body of the Association.

The Council consists of the President, the Vice Presidents (who are ex officio chairmen of the sections), the Administrative Secretary, the General Secretary, the secretaries of the sections, the Treasurer, the members of the Executive Committee, a fellow elected by each of the two regional divisions of the Association, and representatives of the affiliated societies and academies of science. A large majority of the members of the Council are elected by the sections and affiliated societies, which are entirely independent of the Executive Committee and general officers of the Association. It would be difficult to lodge the power of a national organization in a more representative and democratically elected body than the A. A. A. S. Council.

The annual meetings of the Association are in a sense scientific field days, for on no other occasions do men, having such varied scientific interests, assemble to consider their specialities and to learn how much they have in common. They are gatherings of scientists for the discussion of special problems and advances, both in the pure and applied sciences, not for parading wisdom nor making startling predictions. The programs of the meetings are largely organized under the 15 sections in cooperation with the affiliated societies. The affairs of each section are administered by a section committee consisting of a chairman, who is a vice president of the Association for the section, with a term of office of one year; a secretary, with a term of office of four years; four elected committee members and the representatives on the Council from the affiliated societies whose chief interests are in the field of the section.

The secretaries are the chief administrative officers of the sections. They have burdensome and important responsibilities, among which are the planning of programs at the meetings of the Association, generally in cooperation with the officers of several affiliated societies. Many of the programs of the sections and their cooperating societies contain more papers than were in any entire program of the Association for the first 50 years of its existence. Some idea of the present day size of the annual meetings can be gained from the fact that nearly 2,000 papers were presented at the Chicago meeting in 1947.

To avoid the necessity for many members to travel long distances to attend meetings of the Association, a Pacific Division of the A. A. A. S. was established in August, 1915. The territory of this Division includes Alaska, the Hawaiian Islands, British Columbia, Washington, Oregon, California, Idaho, Nevada, and Utah. A Southwestern Division was established in 1920, including in its territory, Arizona, New Mexico, Colorado, Texas west of the 100th meridian, and the Mexican states of Sonora and Chihuahua. These two divisions are entirely autonomous. They elect their own officers, determine the times and places of their meetings, organize their programs, and publish announcements and reports of their meetings in the Association's journals.

Interest in the work of the Association is clearly reflected in its rapid growth in membership, which increased in 1948 by more than 12,000 new members. Membership in the Association is open not only to professional scientists, but also to other persons who find in science pleasure, adventure and opportunities for service to humanity. Professional scientists have joined the Association because of the broad scope of its scientific interests, because of its journals and other publications, and perhaps even more because of the opportunities it offers for coordinating and integrating the natural sciences with social progress. Other persons have joined in order to maintain contact with the great scientific currents that are sweeping humanity onward.

Every member of the Association receives with his membership a subscription for either *Science* or *The Scientific Monthly*, at his option. *Science* is a weekly journal, primarily for professional scientists, that covers the whole field of science. It comprises two volumes a year, each of about 650 pages, and is now in its 109th volume. Historically, *Science* is linked with a journal of the same name founded by Thomas A. Edison in 1880. It has been an official publication of the Association since 1900, and is today the foremost medium in the United States for the prompt publication of reports of current scientific progress.

In addition to "technical papers" from the various fields of specialization, *Science* contains important articles of interest to scientists in general. Special sections of the magazine carry such headings as Association Affairs, News and Notes, Comments and Communications, In the Laboratory, Book Reviews, The Scientific Book Register, Personnel Placement, and The Market Place. In Comments and Communications are found brief critical observations of scientific procedures, conclusions, and objectives, and commentaries on articles published in *Science*.

The Scientific Monthly is the literary magazine of science. It is the medium of publication for scientists who can write understandably and entertainingly about current science, and about the history and philosophy of science and technology. It is neither a technical magazine nor a popular science magazine in the usual sense. It stands between the two, bringing to scientists information and ideas in fields of science outside their own, and opening new horizons to those who are not scientists. Thus, it serves to broaden the knowledge and philosophy of specialists and to illuminate science for serious amateurs who are not specialists.

The forerunner of *The Scientific Monthly*, the *Popular Science Monthly*, was established in 1872, so that for more than three-quarters of a century scientists have written seriously and satirically in this publication. They have done much to disseminate the scientific point of view. Today one will find in it leading articles on both the natural and social sciences; articles of fact and opinion. Special sections are entitled Science on the March, Book Reviews, Comments and Criticisms, and Technological Notes.

Other publications of the Association include the Proceedings and Directories of the Association, and technical symposium volumes. The Proceedings and Directory volume recently published contains the names, academic addresses and business connections, academic degrees, and fields of specialization of more than 40,000 scientists, as well as historical sketches of its affiliated societies. The symposium volumes range broadly through the various fields of science, from surface chemistry to cancer and mental health. These volumes consist of, or are based on, symposia presented at meetings of the Association or on conferences sponsored by the Association.

What of the future of the Association? Instead of looking backward for precedents and inspiration, the founders of the Association looked hopefully forward to a better world through the advancement of science. Such hopes were the driving forces that made the Association the great organization it has become. Under the leadership of Joseph Henry, Louis Agassiz, Simon Newcomb, Asa Gray, William H. Welch, T. G. Chamberlin, A. A. Michelson, Charles W. Eliot, and other great presidents, the most daring dreams and the highest hopes for both science and the Association have been much more than realized. With this example before it at the start of the second century, it is unlikely that the Association will dwell contentedly on a successful past. Instead it looks forward to an arduous future with fixed determination to be worthy of its founders and true to those responsibilities that rest increasingly on scientists.

One of the projects in the immediate future, quite in keeping with the obligations of the Association to science, is the establishment of a great administrative center for independent scientific societies. During most

(Continued on Page 29)

A Co-Curricular Program for Students With Science Potential

• By Paul F. Brandwein, Ph.D., *(New York University)*
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INSTRUCTOR, NATURAL SCIENCES, TEACHERS' COLLEGE, COLUMBIA UNIVERSITY

All teachers are aware that the especially talented high school science student who plans to make science a career should receive special consideration and treatment. But there is no agreement as to procedure.

The plan described here really succeeds. Some of the students' work is good enough to be reported in journals of national circulation. In five years of operation under this plan the Forest Hills school has earned ten first places and thirteen honorable mentions in the Westinghouse Science Talent Search.

This is a stimulating paper.

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There are several kinds of extra-curricular programs extant in the United States. If reports in the literature are typical, most co-curricular (extra-curricular) programs are of the club type where students meet after school and participate in a program jointly conceived by students and sponsor.

At Forest Hills high school we are developing a program which may have some promise. Our experience with one aspect of it is mainly with the biological sciences, although other aspects, e.g. individual "research" work, are fully developed in the physical sciences.

The program is aimed at the student who has science potential; that is, he has the ability and the desire to make science his life work. There is, of course, a wide club program (Camera Club, Museum Curators, Biology Club, Biology Arts Club, Navigator's Club, Chemistry Club, Engineering Society, Agassiz Society (a nature study group), Microscopy Club) for those who may be interested in science but not especially as a primary vocational interest.

For the student with science potential who is interested in the biological sciences our program follows a simple plan. Students may attend a series of lectures, held after school for one hour on one day a week each semester, in botany, invertebrate zoology, physiology, and genetics, on the college freshman level. These semester courses rotate in a two year sequence. On another day in the week, those who desire may attend laboratory work which will eventually correlate closely with the lectures. On another day, those who are interested in special project work may work under two sponsors. Finally, those students who are in their junior or senior year may work during their free periods in the laboratory.

Four teachers are cooperating in this program. The plan is to rotate lectures, laboratory, and project work so that each teacher will eventually participate in all areas during a two year period.

Approximately 40 to 70 students have attended lectures, 20 to 30 attend laboratory, and 20 are in project work, while 10 to 15 juniors or seniors are engaged in work during their free periods. Some of these juniors and seniors will eventually enter the National Science Talent Searches conducted by the Westinghouse Corporation.

The juniors and seniors who work during their free periods are those who have attended clubs and lectures and have shown leadership and success in science. These students are encouraged to select a "research" problem. Each student is assigned to a specific teacher who will sponsor him; that is, he will guide him through difficulties, suggest readings, and help in the selection of a problem. The eventual solution of the problem is the student's own responsibility and may take one to three years depending on the time the student begins to work. The problems vary from—"How long does digestion take in Chaos Chaos (a huge amoeba)?" to "The construction of a mechanical brain." Sometimes the solution of a problem is good enough for publication in a journal, e.g. *The American Naturalist* or *Science*.

In addition, each senior is expected to read a college textbook in biology, chemistry, and physics, and read regularly such magazines as *The Scientific Monthly*, *Science News Letter*, and *The Scientific American*. These are made available in the department office.

The students who distinguish themselves further by their continued effort in solving their "research" problems, by their success in science and mathematics, and by their ability to work with others are elected to a Science-Math Honor Society. The Society publishes a Journal, holds seminar meetings and field trips, and inter-school seminars with other science groups.

If success in the Westinghouse Science Talent Search is an indication of the success of the program, then the results obtained suggest that the co-curricular program plays its part with the curricular program in developing the science potential of students. Forest Hills high school, although not a specialized school, has had ten "winners" selected and thirteen Honorable Mentions in the five years since this program began to yield students who have taken advantage of the opportunities previously described. However, the Westinghouse Search, by its very nature, could not honor all our students with science potential.

It goes without saying that such a program depends on the teachers and laboratory assistants in our science department. We realize that the program helps us meet a special student need and a need of our modern society as well. For the high schools must do their part in feeding the laboratories and science classrooms of the nation. ●

Special Problems in Secondary-School Science Teaching

• By Vernon C. Lingren, Ed.D., *(Columbia University)*
ASSISTANT PROFESSOR OF EDUCATION, UNIVERSITY OF PITTSBURGH, PITTSBURGH, PA.

This is an account of a practical workshop type of course conducted to determine what are the most common problems encountered by secondary school science teachers and to learn how they may be solved.

From nearly 100 problems submitted by a group of teachers, 32 were selected as typical and worthy of study by individual teachers.

The Director of the workshop outlines the problems undertaken. He kindly offers to correspond with readers who are interested in obtaining any of the completed project reports. The reports include the plans used for solving the problems.

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A course called "Special Problems in Science Teaching" has been offered in the division of secondary education by the school of education at the University of Pittsburgh during the past two summer sessions. Placing major emphasis on the solution of practical problems which the members of the class would face in their own secondary schools during the following year, this course revealed the real problems of the in-service science teacher in a functional manner. The enrollment was intentionally limited so that each individual in the class would have an opportunity to present his special problem to the class for constructive criticism.

A total of thirty-two teachers have utilized this workshop type of course as an aid in solving problems which were of concern to them. These teachers returned to their positions in Indiana, Maryland, North Carolina, Ohio, Pennsylvania, and West Virginia with renewed enthusiasm to improve science education in the various subject matter areas, all of which were rather equally represented when the entire group was considered. During the summer session in 1948, each member of a class of thirty science teachers (including fifteen of the teachers referred to above) was asked to state "the three most important professional problems of the secondary-school science teacher in the school with which you are now associated." An analysis of the ninety problems listed led to the belief that the thirty-two projects undertaken by these in-service teachers are indicative of the typical problems facing the in-service science teacher.

The present article will describe the thirty-two problems briefly in an attempt to show the nature and variety of current problems confronting science teachers in the secondary schools.

Readers interested in securing any of the completed project reports, which include proposed plans for solving the problems described, are invited to correspond with the author of this article who was the director of the workshops in which these reports were prepared.

One member of the class, although an experienced teacher, was confronted with a new position in which biology was to be part of his assignment. He prepared a source book of methods of teaching biology. Another teacher worked out a program of motion pictures to be used in the teaching of biology. Two students emphasized the laboratory phases of biology teaching in their study. One of them outlined "a laboratory course of study in biology . . . having many experiments, projects and demonstrations with living and preserved specimens, slides, field trips, movies, charts, etc." The other student sought to build a "laboratory program for the Animal Kingdom" since a suitable laboratory manual was not available for the particular situation.

Eight members of the group chose to work out tentative courses of study for biology, feeling that each school situation needed special attention which it was impossible to give by "adopting a text." The variety of ways in which these eight individuals stated "the problem" is further evidence of this need for local courses of study. One wanted "to develop a course in high school biology that will fit the needs, interests, and activities of the high school sophomore," and he stated his aim in this way: "To develop my *Pupils*, not biology." Another teacher wrote on "Visualized Functional Biology . . ." seeking "to make a course of study in high school biology that will be functional and will make effective use of all available visual aids." "To make a course of study in biology for better living . . ." was the problem of another teacher. The type of student, the parental background, and the school "set-up" were all surveyed as he proceeded to solve his problem. One teacher promised to put forth "an effort . . . to make biology more than just another subject required for graduation . . ." and to "change it to the study of 'Life'—for that is primarily what biology is." Another project report described a course in biology to meet the needs and interests of the students in a school where only one-tenth of the students go on to college. The writer wanted to "materially aid the students in solving their present everyday problems, and prepare them to be more intelligent citizens in a democratic society in this scientific age." One of the courses of study in biology was planned for a class of girls enrolled in vocational home economics. It was to represent their "related science." "The Development of a Biology Course . . . which will be Life-centered" was the topic of one report, and the author sought to prepare projects for

better living by utilizing the teacher's knowledge of pupil's "needs, interests, environments, and outlooks on life." The one remaining problem in course of study construction related to biology was stated as follows: "To begin the development of a course of study . . . based on the text, *Modern Biology*, by Moon, Mann, and Otto." As in the other papers, an emphasis on meeting the needs and interests of a diversified group of students was stressed.

Seven teachers chose to work on projects dealing with problems in the areas of general science instruction. Two of the projects involved the preparation of courses of study. The purpose in one case was "to guide this group of seventh grade students to become effective citizens, through the teaching of science," and in the other instance the problem was to "formulate a course of study which will best satisfy the needs of this group of pupils of varying interests and abilities." Three of the teachers had laboratory-centered problems as their principal interest during the course. One young man admitted a "serious shortage of laboratory equipment" in his school, and studied ways and means of providing suitable demonstrations in spite of the handicap. Another teacher was trying "to set up a laboratory" and was concerned with "fitting it (the new laboratory instruction) into the science schedule." A young lady teacher stated her goal as having "an organized and effective plan of procedure for demonstration and experiments for my ninth grade general science classes during the coming school year." Single studies were made in the field of citizenship education as related to general science teaching, and in the area of administration of a general science program. The former study was titled "Principles and Methods in General Science to Guide the Student to Become a Sound Intelligent Citizen," and the problem in the latter project was a "Plan for Coordinating the Work of the General Science Teachers in the Ninth Grade of the . . . Junior (High) School."

Four of the teachers studied problems relating to the teaching of chemistry. Two of the men from one school made companion studies in that one of them worked with the course in chemistry intended for pre-college pupils, while the other worked out a course "for those pupils who do not anticipate college study and those who may attend college but will not pursue the study of chemistry further." A second project report dealing with a course of study for non-college pupils was written by an instructor in another school, and was unique in that it gave special attention to the possibility that some of the pupils would enter the pottery industry in the community where the school was located. The one remaining paper on chemistry dealt with the "Logical Preparation of a Regular Course in High School Chemistry by the Unit Method."

Three physics teachers aided the workshop groups in gaining an insight into problems in this field by preparing reports which were labeled "A Problem in Teaching Physics," "A Course of Study Using Basic Principles of Physics," and "A Functional Course of Study in Physics." The author of the first paper devised "A plan which will give the college preparatory students the basic grounding in the subject they ought to have and at the same time and in the same classroom will offer to the other students a more humanized and practical physics course of a terminal nature." The second paper described an investigation of "basic principles of physics and the experiments and demonstrations which would best help to make those principles a part of the pupils' intellectual equipment." The final paper in this group was devoted to the development of a course of study in physics which is intended to serve much the same dual purpose mentioned previously—pre-college and non-college goals.

The general area of senior science was represented in the group by three interesting studies. One dealt with "Chemical and Physical Experiments for Use in Consumer Economics Courses" in which the objective was "to make the consumer economics course more realistic and practical." Another teacher developed a course in "Practical Science" for the eleventh and twelfth grades, while the third prepared a "Tentative Outline of a Generalized and Practical Course in Science for Non-Academic Students in the Upper Secondary-School Grades."

This article has thus briefly described projects in the fields of biology, general science, chemistry, physics, and senior science. Three studies omitted from the discussion up to this point because of their more general nature complete the listing of thirty-two reports. One teacher outlined "A Plan to Construct and Equip a Chemistry-Physics Science Room," while a second prepared "A Plan of Organization for a Science Club . . ." The one college instructor in the workshop wrote on the "Development of a Testing Program in General Chemistry Excluding the American Chemical Society Cooperative Test."

The brief mention permitted here does not adequately reveal how carefully each graduate student worked in solving the problems which were peculiar to his own local school situation. A reading of the complete reports, however, does give the impression that sincere teachers are seeking to solve these problems in a realistic, practical way. The complete titles usually included the name of the school in which the plan of action was to be used, but for the purpose of this general article such identification has been omitted.

No attempt has been made in this summary to explain how these problems may best be solved, or when advisable, avoided. The complete project reports which are on file in the office of the writer would be of interest and of help to educational workers who are seeking to solve similar problems. As indicated previously, these documents may be obtained by writing to the author. It is sincerely hoped that further study of additional problems will be encouraged so that the important field of science education may be improved in the future. ●

JOSEPH PRIESTLEY, Pennsylvania Scientist

• By Joseph Samuel Hepburn, M.D., Ph.D., *(Columbia University)*
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PRESIDENT, CITY HISTORY SOCIETY OF PHILADELPHIA.

The eminent scientist-historian who writes this important paper has made a special study of Priestley's life in America. Here he presents little known facts about this "celebrated theologian and philosopher, discoverer of oxygen and founder of modern chemistry, inflexible defender of human rights."

Seen against the background of his time the Priestley picture gains clarity. Dr. Hepburn supplies many intimate details.

Teachers of chemistry will be appreciative of the information given here.

In the year 1794 Philadelphia, the capital of the United States and of the Commonwealth of Pennsylvania, was an educational, medical, and scientific center.[1, 2] The University of Pennsylvania had been formed in 1791 by merger of the College, Academy and Charitable School of Philadelphia, (which traced its origin to 1740 and its activities as an institution of higher learning to Benjamin Franklin's "Proposals Relating to the Education of Youth in Pennsylvania" in 1749) and the University of the State of Pennsylvania, which, upon its creation in 1779, had been the first state university and also the first American institution to have the word university in its corporate title.

The University possessed the first American medical school, founded in 1765; chemistry had been taught to its students in arts as early as 1756 by the first provost, William Smith, and as early as 1765 to its students in medicine by John Morgan, a pupil of William Cullen at Edinburgh. In 1769 it had created the first professorship in America devoted exclusively to chemistry with Benjamin Rush, a pupil of Joseph Black at Edinburgh, as its first incumbent. The 'Syllabus of a Course of Lectures on Chemistry" by Rush, published in Philadelphia in 1770, was the first American chemical text[3]; it ran through several editions.

During this epoch, a "Chemical School" existed at the University; one of its products was Robert Hare who invented the oxyhydrogen blow-pipe. The first American hospitals were in Philadelphia; the Pennsylvania Hospital had been incorporated in 1751; the hospital of the Philadelphia Almshouse, now known as the Philadelphia General Hospital, traces its origin to 1728. The American Philosophical Society had been founded in 1727 by Benjamin Franklin. It began the publication of its *Transactions* in 1769, and occupied its Hall in Independence Square in 1789. David Rittenhouse had succeeded Franklin as its president in 1791, and was succeeded by Thomas Jefferson in 1797. The first chemical society in the world, the Chemical Society of Philadelphia, was founded in 1792 and existed for about seventeen years. Its founder and, apparently, its first and only president was James Woodhouse[4].

To Philadelphia, in 1794, came Joseph Priestley on his journey from England to his new home at Northumberland in Pennsylvania, at the forks of the Susquehanna River, where he spent the last decade of his life (1794-1804). Priestley is best described by a portion of the legend on a tablet at the original site of the University of Pennsylvania in Philadelphia as "celebrated theologian and philosopher, discoverer of oxygen and founder of modern chemistry, inflexible defender of human rights." Priestley was a protege and a friend of Benjamin Franklin who called him "the honest heretic" in a letter to Benjamin Vaughan[5]:

> "Remember me affectionately to good Dr. Price, and to the honest heretic Dr. Priestley. I do not call him *honest* by way of distinction, for I think all the heretics I have known have been virtuous men. They have the virtue of Fortitude, or they would not venture to own their heresy; and they cannot afford to be deficient in any of the other virtues, as that would give advantage to their many enemies; and they have not like orthodox sinners, such a number of friends to excuse or justify them. Do not however mistake me. It is not to my good friend's heresy that I impute his honesty. On the contrary it is his honesty that has brought upon him the character of heretic."

Priestley came to the new world in search of civil and religious liberty. His chapel and his home had been destroyed by a mob in the Birmingham riots of 1791, primarily because of his sympathy with the French Revolution. This sympathy caused Edmund Burke, in his "Letter to a Noble Lord"[6], to vent his ire on Priestley after the latter had settled in America.

Priestley remained a British subject; in 1798 he wrote to Benjamin Vaughan[7]:—"I have no thoughts of going to France before a *peace*, or of ever becoming a citizen of the United States. In my case, it could not answer any end whatever. I choose rather to live as a *stranger* in the country." Yet Priestley's letter in 1797 to Judith Mansell[8] of Birmingham implies his decision to make his permanent home in the United States:—

> "Your kind letter to my wife reminds me of what I ought to have done before, and which indeed I thought my daughter in law had done for me, viz. to inform you of the melancholy word of her death—. If it was not for the assiduity of my son Joseph and his wife, to make me as comfortable as they can, I should leave this country; though I should feel more than you will conceive to leave the place where she and Harry are buried. I wish to make my friends in Europe a visit before I die, but I would not be separated from them even in death."

Harry, mentioned in this letter, was Priestley's son

Henry who died at Northumberland on December 11, 1795, aged eighteen years.

Priestley's activities in America were theological, scientific, and educational. His theological activities were primarily on behalf of the Unitarian church. As a scientist, Priestley had become a Fellow of the Royal Society in 1766, a foreign associate of the Academy of Sciences of France in 1772, a foreign honorary member of the American Academy of Arts and Sciences in 1782, and a member of the American Philosophical Society in 1785. He was a member of the Chemical Society of Philadelphia, received the degree of Doctor of Laws from the University of Edinburgh in 1765, and was awarded the Copley Medal of the Royal Society in 1773 for his researches on fixed air or carbon dioxide.

In his home at Northumberland, Priestley had an excellent library and a well-equipped laboratory. Much of his apparatus has been preserved in several institutions.[9] He ordered supplies through John Vaughan of Philadelphia[9, 10] and also received them from abroad. Thus Vaughan was requested to send oil of vitriol, pure gold, and pure silver. In a postscript to a letter to Vaughan, dated April 11, 1799, Priestley inquires concerning a large piece of platinum brought from Spain for him.[11] From England came glass apparatus, some, apparently, highly specialized, "things that have no names and require drawings to give an idea of them." Priestley was exceedingly disappointed with apparatus of American manufacture, and greatly disturbed by damage to glass apparatus during passage through the customs and as a result of improper repacking.

As a member of the American Philosophical Society, Priestley attended its meetings when in Philadelphia, communicated to it the results of certain of his researches, and published them in its *Transactions*.[12] Most of these researches dealt with gases. In 1799, an account was given of the passage of certain vapors (spirit of nitre, marine acid, nitrous acid) chiefly over metals in a hot earthen tube. This was followed by pioneer work on gaseous diffusion, the transmission of gas through earthen vessels of a very close texture, so as to be apparently impervious to air, different gases being within and without the vessel. When two gases were separated by a bladder, at times transmission of both gases occurred through the bladder.

In 1800, another research dealt with heating various gases and gaseous mixtures in tubes of iron, copper, silver, and gold. In 1803, record was made of the occurrence of nitre in common salt which had been frequently mixed with snow. In the same year, observations and experiments relating to equivocal or spontaneous generation were reported. The research was conducted on pump water to which raw potato had been added. It extended over a period of 74 summer days, and the appearance of the "green matter," which produces dephlogisticated air by the influence of light, was observed and recorded. It began to appear in about one week in a wide-mouthed open vessel, in three weeks in a large narrow-mouthed decanter, in one month in a vessel with a loose tin lid, and in two months in a glass stoppered phial, but did not appear in vessels covered with olive oil or in a vessel which had its mouth inverted in mercury.

> "The wider was the mouth of the vessel, the sooner did the green matter appear in it;—in time the germ (or whatever it may be called that produced it) found its way through the smallest apertures,———. These experiments, therefore, are far from favoring the doctrine of spontaneous generation, but are perfectly agreeable to the supposition that the seeds of this small vegetable float in the air, and insinuate themselves into water of a kind proper for their growth, through the smallest apertures."

During this period, Priestley also contributed to other scientific periodicals. In 1802 he published, in Nicholson's *Journal*, a paper on the "*gazeous*" oxide of carbon obtained from finery cinder and charcoal, *i. e.*, carbon monoxide. "It cannot, however, be denied, that this gazeous oxide of carbon is *inflammable*. ——— This air, therefore, from finery cinder and charcoal, though called an *oxide*, must be essentially different from all the other oxides, none of which are combustible being substances already saturated with oxygen."[13]

Results of his researches also appear in his correspondence. Thus Priestley[7] wrote to Benjamin Rush on May 22, 1795, that he had "made trial of the air of Northumberland by the test of nitrous acid, but found it not sensibly different from that of England."

Priestley remained an ardent phlogistonist. At Northumberland, he published in 1800 a treatise of 106 pages entitled "The Doctrine of Phlogiston Established and that of the Composition of Water Refuted," which appeared in an enlarged edition of 143 pages in 1803.

The stimulation of scientific studies in America by the arrival of Priestley has been stressed by Edgar Fahs Smith.[4, 14, 15, 16] Thus Woodhouse, his pupils, and his colleagues in the Chemical Society of Philadelphia worked zealously on problems in theoretical, applied, and biological chemistry.

Priestley[9] was unanimously elected professor of chemistry in the University of Pennsylvania by its Trustees on November 11, 1794. His declination of the professorship was reported to the Trustees on March 3, 1795. James Woodhouse was elected to the chair on July 7, 1795. In 1803, Priestley declined to become a candidate for the vacant office of Provost of the University.

As an educator, Priestley was deeply interested in the institution at Northumberland which he usually called a college, but which actually was an academy. He mentions it in letters to John Vaughan[11] on January 4 and August 11, 1795, also in another letter to John Vaughan[17] on January 26, 1795. In letters to Benjamin Rush[7], Priestley mentions the scheme for the college on September 14 and October 28, 1794, and speaks hopefully of the plan for it on November 3 and November 11, 1794, and on May 22, 1795. In a letter to William Withering[7] on October 27, 1795 Priestley announced that he had been appointed principal of the college, and that building would begin in the spring. This institution is mentioned in the "Memoirs" of Priestley[18]. It received legislative appropriations in

(Continued on Page 32)

That's What Perfumes and Flavors are Made of

• By Joseph Baird Magnus
VICE PRESIDENT, MAGNUS, MABEE & REYNARD, INC., NEW YORK CITY

Few people realize the magnitude of the flavor and perfume industry, or the wide variety of natural and synthetic products that enter into its products.

This is an account of some of the ways chemists make the things we eat, the articles we use, and the places we live in more pleasant to our smell and taste. You may not know that linoleum, library pastes, insecticides, printing inks, motor greases, and many other familiar products have been made more attractive by treatment with aromatic products.

This brief article by one of America's outstanding authorities supplies new information.

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Through the centuries the demands of civilization, ever on the increase for greater creature comforts, have called for a wider knowledge and use of aromatic materials for perfuming and flavoring virtually everything we use from the cradle to the grave. Biblical writings mention such substances as myrrh, cedar, frankincense, cinnamon and various aromatic gums, all of which constituted the foundation of what at present we term the essential oil and aromatic chemical trade. During 1948, manufacturers in the United States, in nearly 65 different types of industries, used over a hundred million dollars worth of aromatic chemicals and related items.

What is an essential oil? It is an oil obtained from a plant, root, bark, leaf, herb, or any part of the vegetable kingdom having the characteristic odor and/or taste of that part of the plant, and which is volatile in steam. An aromatic chemical, as the name implies, is any chemical having a pleasant odor or taste used in the making of flavors and perfumes. For example, otto of rose is the essential oil of roses, used primarily for odor, and peppermint oil is the essential oil of the peppermint plant, used as a flavor. Vanillin is an aromatic chemical used to give the taste or odor of vanilla, and methyl salicylate is artificial wintergreen oil.

The essential oil industry is a manifold business of supplying ingredients to soap, cosmetic, pharmaceutical and food manufacturers and a host of other manufacturers and many other trades such as baking, candy, canning, condiment, sauces, and salad dressings. Thus almost every minute of our life we come in contact with products flavored and perfumed by the use of aromatic bodies. The field of aromatic chemicals alone is of tremendous scope. Many of Nature's finest perfumes, found in flowers and odoriferous plants, can now be duplicated in the laboratory. The flavor of fruits and the tang of spices are now faithfully recreated in abundant amounts and at a very nominal cost compared to the natural products. The perfuming of products in which objectionable odors cause sales resistance is a major job. Oftentimes complicated and difficult situations are encountered in solving these problems.

When we arise in the morning we brush our teeth with a mixture of soap, salt and other ingredients to which a pleasant flavor is added in the form of essential oils such as peppermint, spearmint, clove, etc., or a specially prepared toothpaste flavor, or a combination of all or any of these. An aftershave lotion would be an unpleasant preparation of practically raw alcohol if it did not have a perfume oil. Talcum powder, at a cost of one or two cents a pound in its untreated state, is increased in value by the simple manufacturing procedure of sifting and perfuming it with a high-grade perfume oil, and packaging it in an attractive container. Lipsticks, face powders, hair shampoos, soaps are also made attractive to the consumer in like manner. The atmosphere in our cities would be less pleasant were it not for the treatment given to gasoline and motor

JOSEPH BAIRD MAGNUS

greases with aromatic products. No fur coat, no leather article, would be very attractive to the nose if not impregnated with an odor that is usually not recognized as a smell at all.

Civilized man is indeed a fastidious animal; things have to smell and taste right before he will accept them for use. There are a few exceptions—such as limburger cheese—but even that tastes good under certain circumstances, for example, with onion, pumpernickel and possibly unsalted butter. When we are sick and the physician prescribes a liquid medicine for us he usually endeavors, whenever possible, to incorporate some sort of aromatic elixir with it so that its taste will be more pleasant.

Some years back our essential oil house was called on to perfume a flea powder to be used on dogs. The question arose as to whether the odor ought to please the dog or attract the flea! The real answer was that the consumer—the owner of the dog—was to be pleased.

Other industrial products that come under the scrutinizing eyes and nose of essential oil technicians include such well-known items as insecticide sprays, and space sprays (for the removal or neutralizing of the odors of cooking; bathroom odors, mustiness in closets and cellars, etc.) Germicides, with strong odors of their own, are a difficult problem, and so are mixtures such as formaldehyde with various alcohols. The essential oil chemist is called upon to deodorize linoleum, oilcloth, paints and varnishes, printing inks, polishes of all types, library pastes, embalming fluids, rubber products and hundreds of other things that would be offensive to our noses if they were not treated for their "halitosis."

In the flavoring field we come into still wider applications. Prepared meats and meat products do not taste nearly as good without the addition of spice essential oils. Almost every kind of prepared meat has its own combination of spices—from the dry type of sausages to the well-known frankfurters, liverwurst, balonies and cold meats of all descriptions. Salad dressings, sauces, cordials, cough remedies, condiments, catchup and chili sauce, maraschino cherries, candy, breath preparations, and a host of baked goods and other food preparations meet the scrutiny of technicians interested in bettering their products by means of flavoring oils and scientifically prepared flavors.

The various types of essential oils may be classified roughly as follows:

1. *Citrus Oil Group.* Obtained not from the pulp or juice, but from the oil cells in the skin of the fruit. The oils of such fruits as lemon, orange, lime and grapefruit are used for their flavor in soft drinks, household extracts, candies, ices, and pharmaceutical products, and wherever a pleasing citrus flavor is desired.

2. *Floral Oil Group.* Distilled usually from the petals of flowers. These precious oils are used in perfumes, highgrade soaps and cosmetics. During the recent war a great many replacements were discovered and developed from aromatic chemicals. The natural oils come mostly from France, Spain and other countries in the Mediterranean area.

3. *Camphoraceous Oil Group.* Brown camphor oil, from the camphor tree of Formosa and Japan, yields such other oils as oil of camphor water white; yellow camphor oil, artificial sassafras, and others. Their chief use is in liniments, disinfectants, and other pharmaceutical products.

4. *Spice Oil Group.* This large group includes such distilled oils as cinnamon, nutmeg, clove, coriander, etc. They are indispensible in canned meats, pickles, confections, and practically every other prepared food we buy.

Essential oils are gathered from the four corners of the earth. Virtually every country, with few exceptions, is a supplier of some type of essential oil or odoriferous product. Merely to enumerate the distant countries from which our common essential oils come will cast a romantic spell. We have the spice oils of the Indian Ocean such as those of the Reunion Islands and Madagascar. From Ceylon comes citronella as well as the cinnamon that is known as Celyon cinnamon. Java sends us its own type of citronella. The southern states of India are distillers of sandalwood oil and vetivert oil. We have cassia and anise oils from the hinterlands of Hong Kong. The camphoraceous oils, as mentioned, originate in Formosa and Japan. In ordinary times Russia is a producer of such useful items as birch tar oil and Siberian pine needle oil. We have the widely-used and very necessary eucalyptus oil from Australia as well as, to some extent, from Formosa. Many of the seed oils originate in central Europe such as coriander, sweet basil, celery and others. Paprika, a native of Hungary, is a very important flavoring ingredient in prepared meats and other products.

Catnip oil is distilled in Canada, and from this northern neighbor we also receive fir balsam of the very highest type. Mexico is an important producer of linalol and the ever-popular lime oil. The West Indian islands and many countries of South and Central America add to the long roll; orange oil and menthol from Brazil, balsams from Venezuela, Salvador and Colombia, vanilla beans from Mexico; Tahiti vanilla beans from the southwest Pacific. Of late, points in Africa have started production of important essential oils and now supply much of the capsicum formerly imported from Hungary.

Floral oils come mostly from the Mediterranean countries. Tuberose and jasmine are imported from the southern districts of France; geranium oil is produced in the French possessions of North Africa. The pure rose oil is produced in Bulgaria and to some extent in Turkey. Chamomile, peppermint and other plant essential oils are made in England.

However, probably no country in the world produces such a wide variety as our own. Carrot, celery and parsley seed oils; bay, birch, pine, spruce and cedar-

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Using Instructional Films in Science

• By Warren P. Everote, Ph.D., *(Columbia University)*
ASSOCIATE IN RESEARCH AND PRODUCTION, ENCYCLOPAEDIA BRITANNICA FILMS, INC., WILMETTE, ILLINOIS

Instructional films for science classes are dependable. They overcome such limitations as imperfect techniques and lack of time for preparation on the part of the teacher, or failure of equipment used in experiments or demonstrations.

Films do not replace the teacher; instead they implement his teaching. Each teacher must develop utilization techniques suited to his own style of teaching. This paper points out how science films may be used to the best advantage.

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Few devices growing out of our twentieth century technology offer as wide a range of possibilities for human enlightment, inspiration, and enjoyment as does the motion picture. Originally conceived for entertainment purposes, motion pictures are now used extensively in the classroom as well as in the theatre. The development of the instructional or classroom type of motion picture has been rapid, and its improvement has gone steadily forward. Naturally, in the utilization of this kind of instructional device, new ideas and new techniques are continually being tested, then rejected or tentatively accepted.

The instructional film, when well-executed, is a remarkable vehicle of communication; but its effectiveness as an educational tool is directly related to the skill with which it is utilized by the teacher. Before considering what is involved in effective utilization of films, it seems appropriate to summarize the attributes of an instructional film of excellent quality. Fundamentally, such a film—in the present instance, a science film—includes concepts and facts carefully selected and presented in order to accomplish specified objectives. These concepts and facts, so far as may be possible, are of general social, as well as specific scientific, significance. The film treatment clarifies these concepts and facts by means of the most effective organization of data attainable. The data used are unimpeachable, completely authentic in so far as accepted theory and current research permit them to be. The film excels in terms of language, logic, and photography. In effect, the good instructional film can be relied upon by teachers to provide selected and authentic experiences for the classroom, and to do so in a manner consonant with excellent teaching practices. The instructional film brings to the classroom selected aspects of the world's culture. In effect, it can transport the student to the factory, to the farm, or to the laboratory. It can clarify and amplify concepts and actions. It often can do these things more effectively than even the finest teacher because the resources available to the film medium are almost unlimited.

Careful film selection is so closely related to adequate and effective film utilization that the two are almost inseparable. Several considerations are particularly important in the selection of an instructional film. First, it is essential that the teacher determine what specific objectives are to be served by using motion pictures. Once this is established, the teacher decides what kind, or kinds, of film presentations will fulfill these objectives most effectively. This is why the trained user of instructional films evalutes the different types of films available when selecting those for a given purpose. For example, a film relying principally upon animation may be the most effective one. Drawings made dynamic through appropriate animation can symbolize techniques and processes which could be visualized in no other manner. Or perhaps a study requires that objectives be magnified. By means of a film every member of an audience, in effect, looks through the same microscope or the same telescope or the same telephoto lens at the same instant. By means of camera technique the screen size of insects, such as ants or mosquitoes or butterflies, can be greatly increased thereby revealing the actions of the individual or the colony. The advantage of the medium in this situation is obvious.

Perhaps the teacher requires a film depicting objects unavailable in the classroom, or perhaps he wishes to demonstrate techniques that he, himself, could not possibly perform. In these situations the film is almost indispensible. Even routine experiments often may be better presented by means of the film medium. Once they are recorded on film there is never a loss of class time through failure of equipment, imperfect technique, or lack of time for preparation. The film can show processes that cannot otherwise be seen or studied in perspective. For instance, consider time-lapse or stop-motion photography. By means of this type of visual reporting, phenomena encompassing a time span of months in nature, are compressed into seconds of screen time as exhibited on a few feet of film. In this acceleration of motion, much is gained because actions, such as the unfolding of a flower, that ordinarily occur too slowly for the unaided eye to detect are revealed in continuous rapid action. By means of slow motion photography, motion may be decelerated. For example, cameras now available can photograph a high speed projectile in flight travelling at a rate so slow that the projectile barely seems to move across the screen.

These are but a few of many motion picture techniques which help students and teachers improve their understanding of their environment. The teacher who is aware of these potentialities, and who knows what is available, can select the most appropriate films to meet the specified purposes that he feels are required for his program.

In the early days of films for the classroom, relatively few teachers used them. Many schools did not own equipment, appropriate films were rare, and teachers and administrators knew too little about instructional films to use them effectively. But, gradually a transition has occurred until now films are used widely. With increased utilization has come a clearer understanding by more and more teachers of the magnitude of the job involved in effectively integrating films into the school program.

The film does not replace the teacher as some have suggested that it might. Nor does it relieve the teacher of preparation. What it does do is to implement his teaching with one of the most powerful teaching tools ever devised. Through the use of films the range of materials the teacher can present is increased almost infinitely. But with a device so powerful and with possibilities so great, there is an increased obligation for the teacher to prepare his film presentations with exceeding care, to show films under the best possible conditions, and to follow through with well planned activities.

Almost every teacher who uses motion pictures has developed utilization techniques to suit his own type of teaching. Certain basic techniques, however, are generally agreed upon. First, the teacher should understand clearly what a given film purports to do; and second, he should know precisely how to fit the film into the science-course work being undertaken. But knowing these facts is not a guarantee that they will be translated into action. Stated positively, the teacher should prepare the class to see the film so that every student knows in advance what to look for. Every effective film has certain highlights and the class should be prepared in advance to be alert in recognizing and relating them to the science problem upon which they bear. To prepare the class for seeing a film, the teacher himself must be well prepared. This involves previewing the film if it has not been seen previously. If a preview is impractical, a review of the film continuity is desirable. This is usually provided in the handbook prepared by the film maker. In addition to a knowledge of film content, it is important that the teacher determine what objectives the film serves. Finally, the teacher should be prepared to relate the film to the class work and to suggest further studies growing out of the showing.

Presentation of the film also requires careful execution. There are always physical problems such as focus of the image on the screen, acoustic conditions, temperature of the room, ventilation. Such factors may well be the difference between an effective and an ineffective showing. Any diversion during the screening period is wasteful and distracting. It is the screening that provides the students and the teacher with a set of shared experiences which can be used as the basis for further study, for reflective thinking, and for constructive action.

Once the film is screened, the follow-up begins. It is in the follow-up stage that plans for further study are determined. Drawing tentative conclusions, summarizing ideas presented, rethinking previously held ideas or tenets, exploring new areas and related problems are examples of follow-up activity. Achieving these outcomes requires the most professional guidance that the teacher can provide. The teacher may assist the students by helping them develop discussions and formulate plans for field trips; by channeling student energy into the construction of models and drawings; by assigning readings; by formulating problems to study and experiments to execute; and by creating other kinds of learning experiences.

Outcomes of teaching with instructional films are measured in terms of student growth, just as is true of any other kind of effective teaching. One phase of student growth that can be measured with relatively little difficulty is the retention of factual material. But another kind of growth—one much harder to measure and much more important than the mere retention of facts—is the development of student concepts and perspectives. Essentially, this reflects the ability of an individual to use data effectively. It is the kind of growth that is best evaluated by observing a student's behavior and his responses to problems. In other words, does the film experience make any lasting contribution to the student's personality? Does it help him improve his ability to solve problems? Does it help him relate facts and translate them into action? Does it lead him to more effective investigations?

During post-screening discussions the teacher usually finds it desirable to review all, or at least certain parts, of the film with the class. After the review—possibly the following day—the teacher may find that a rescreening of the film will clinch the concepts even more strongly. Particularly in science, at least one review of a film is essential if full value is to be derived from the picture.

Some film makers are now producing filmstrips made out of key scenes taken from motion pictures. Where such a filmstrip is available, a teacher can use it to help the class review salient points in the film. Often the filmstrip is the best way in which certain objectives or relationships can be studied; because with this device the teacher can progress at the rate of speed he judges most suitable for a given class, as well as present such supplementary data as he thinks essential in conjunction with any scene.

To make future showings of a film more effective, the teacher may wish to maintain a card file or other reference system in which pertinent facts concerning each film are recorded. Catalogues published by film producers and by film distributors are also helpful in over-all planning. Many school systems have their own catalogues of available films and some systems have film specialists who can assist teachers in selecting and utilizing films. But, fundamentally, the values derived from instructional films are functions of the individual teacher's ability to use them effectively.

The film is not an end in itself. Rather, it is a device by which new vistas are introduced into the classroom and ideas and concepts are given a measure of reality unmatched by most other kinds of teaching aids. But the value of the instructional film, judged in terms of student growth, is directly dependent upon the ability of the teacher to use effectively this modern medium of communication. ●

Two Beginnings to Every Scientist

• By Herbert S. Zim, Ph.D., (Columbia University)
ETHICAL CULTURE SCHOOLS, NEW YORK, AND MANHASSET BAY SCHOOL, PORT WASHINGTON, NEW YORK

One of the major accomplishments of the National Science Teachers Association is the creation of the Junior Scientists Assembly which is held in conjunction with the annual meetings of the Association and the American Association for the Advancement of Science.

The Assemblies bring together teachers, scientists, and talented junior scientists to discuss the special problems of young people in science.

Dr. Zim has been active in the Assemblies. He discusses the consideration that should be given especially capable students in high school and college, and shows how these meetings aid both teachers and pupils.

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The ancient and honorable truism about all things having had a beginning applies to scientists as well—except that the making of a scientist has two beginnings. Both have significance for science education, and in recent years research in science education and the creation of the Junior Scientists Assembly have brought these dual beginnings of the scientist into clearer focus. The matter of the origin of science interests and their subsequent development is something science teachers want to know more about because all of them are acutely aware of the close relationship between interest and progress in science, as well as in other fields of learning.

Teachers of science have long been concerned over what has now become "science in general education." At one time we spoke of science for citizenship and, in a somewhat narrower sense we had general education in mind. The goals of science teaching—that is all science teaching on the elementary level, nearly all on the secondary level, and a major part on the collegiate level—are encompassed in this broad, basic goal. But over and above those who will use science in their daily life are the young people with strong science interests who want to enter the scientific professions. Within the total school population this is a very small group, indeed. But its size is no indication of its importance.

Some teachers are apt to brush aside the problem of science education for the scientific professions and even affirm that no problem exists. They argue with recognizable logic that education on the primary and secondary levels is general education. We have, it is true, vocational training for those whose formal education has to terminate on the high school level. But when education is extended beyond high school, as for potential scientists, there is a feeling that the academic secondary program is sufficient. After all, in most secondary schools the student will take several science courses and be required to take a number of related tool subjects. Hence professional training or even the choice of a professional career is not a matter of prime importance. The high school senior has ample time to decide if he wants to become a doctor, chemist, geologist, or astronomer.

Logical as that point of view may be and consistent with current educational practice, it takes a header when confronted with the facts that come to surface when we look more closely at the young people who want to be some kind of scientist or who are actually training for scientific careers. Those who have skirted the problem of what makes a scientist are well aware of the meager information on hand and the complexity of the unanswered questions ahead. But one of the few things we know with reasonable certainty is that young people who want to become scientists usually become interested in science at a very early age—a large majority before the age of 12. Practically no one after the age of 15 makes the sudden decision to become a scientist. These are not mere statements by young people regarding a vague, vocational ambition. The young person who is interested in science rapidly develops a pattern of activity which is usually clear and definite by the time he is in his early teens.

Such a boy (and the chances run from about 5-1 to 10-1 that it will be a boy rather than a girl) will probably begin as a collector—perhaps of rocks or mineral, leaves, flowers, or chemicals, shells or just miscellaneous scientific materials and apparatus. He will also be doing a good deal of "experimenting"—with chemical sets, electricity, microscope, photography, or radio. He will build and design apparatus and equipment. Much of this work is done at home in a corner of a room or in the cellar, attic or kitchen. Many build labs of their own in which to work. If the school offers the opportunity, these young people spend extra time around the science laboratory. They help the teacher on routine jobs, work on projects, and perform extra experiments. They are usually active members of science clubs. Their reading, conversation and other related out-of-school activities all fall into this same persistent science-centered pattern.

The most significant of all is the amount of time these interested youngsters spend with their hobbies—for at this stage the activities are on a hobby level even though clear vocational interests are expressed. A large part of the total available time goes into these activities at a time when the school week, home, and social activities set up a full program too. Besides, much of their allowance, often supplemented by money they earn, goes into supplies and science equipment. In the light of these facts, it is not surprising to find

that young people who want to be scientists are well on their way toward their goal at a time when few of their agemates have any serious vocational interest. The amount of scientific information and related scientific skills these young people command is commensurate with the time and effort they have put into their work. Teachers are often astonished by it. Yet it is common to find that these pupils, before they have graduated from high school have studied, on their own, college texts in chemistry, physics, biology, and related subjects and have even gone into advanced references and research publications.

The fact that young scientists do get such an early start and often make such prodigious progress deserves our attention. We need to consider how we are meeting the needs of these particularly talented pupils and how we can best guide them in their work. The task of aiding specialized talent within the framework of general education is no easy matter, especially at a time when, as during adolescence, special attention must be given to personality development. The early nurture of such interests and the encouragement of interested pupils put an educational emphasis at the very fountainhead of science. One cannot overestimate the value of attention and guidance given to science interested pupils in their early teens.

The second beginning in the life of a scientist is almost as important to the young person as the actual inception of the science interest. This critical period makes its appearance during the early years of college. To grasp the situation fully and its attendant problems one must again look at the interested young people who are on the way to become scientists. A process of weeding out is constantly thinning their ranks, even though interest and ability are present. Finances may make a college education impossible. Parental aims and aspirations often overrule the young person's ambition, especially when so much seems at stake to the adolescent in this complex society. Hence the inherent danger in talent searches that call for the participation of thousands and select only a few individuals. Many must modify their ambition to become scientists of research rank and fit into jobs of lower creative responsibility.

As the young potential scientist moves into college he becomes more and more aware of these and related problems. But problems or otherwise, the student usually moves ahead rapidly. In some of the cases reported these young people begin science research on a professional level even before entering college, and most are working on problems or projects when their classmates are still thinking in terms of courses and grades. Their self-accelerated progress moves them faster toward their professional goals than the related educational system through which they must work. But these college scientists no longer go down to a cellar lab to experiment. Many are ready for professional experience and such experiences have tremendous educational as well as personal values. One channel that opens the door to science as a profession to these junior scientists are summer jobs in laboratories where they work, talk, and literally live with scientists, or the parallel experience of a summer at some research station. As a byproduct of some of this summer work or of part time research which parallels their college courses, these juniors sometimes receive a credit line in published reports of research. Sometimes their participation is such that they are accepted as one of the research team and as a joint author of the report. Such an experience adds considerably to the individual's prestige and to his feeling of professional status. Many call these the key experiences of their late adolescence. There was undoubtedly something in the old apprentice system which might be of real value in the education of the professional scientist.

Another channel to achieving the professional status is being developed through the cooperative efforts of science and science education organizations. The effort is multipurposed, but the purposes are closely related and, in function, they blend. This effort had its origin at the close of the war years when the devastating effects of the draft program on this country's available group of young scientists became painfully clear. Early in the fall of 1946, at the suggestion of Dr. Otis W. Caldwell, the Executive Committee of the American Association for the Advancement of Science organized a committee under the leadership of Dr. Morris Meister, then President of the National Science Teachers Association, to consider the problems of young scientists. This representative committee planned the first meeting of the Junior Scientists Assembly which was held concurrently with the annual meeting of the A.A.A.S. in Boston in 1946.

The aim of the Junior Scientists Assembly, which is now an established annual event, was to create a situation which by involving the participation of young scientists, would permit teachers, scientists and the junior scientists themselves to discuss the special problems of young people in science. The actual meeting of the Junior Scientists Assembly has taken the form of a panel discussion by a number of invited young scientists. At its first meeting the panel tackled the broad topic, "The young scientist looks at education and at his work." The young scientists had a number of concrete suggestions to make about science education. Judging from the nodding heads of the professionals in the audience their viewpoint was very much appreciated.

At the second Junior Scientists Assembly, held in Chicago during Christmas week of 1947, the panel discussed, "The importance of extra-curricular science activities to science-talented youth." At the third annual meeting of the Assembly, held in Washington in 1948, the theme was "Young scientists view science education for all American youth." At these meetings, too, there was a lively challenge of young minds tackling new problems—an opportunity for some of the outstanding science students to come back and give their teachers a consumer's view of science education. The direct results of the exchange of ideas has been as rich an experience for the audience as for the participants.

But the functions of the Junior Scientists Assembly go farther. First of all, the meetings bring together a

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Teaching Summer Classes in Science

• By Sister M. Gabriella, O.S.F., M.S., *(University of Pittsburgh)*
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This pleasant account of the methods successfully employed by a Sister in teaching other Sisters summer classes in physiology and nature study contains instructional hints that may interest other teachers.

The difficulties surmounted as well as the satisfactions gained are discussed.

Even Sisters don't like insects!

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In the summer of 1948, with little advance notice, I was assigned to teach two classes in science during the vacation period. I was perplexed. A number of difficulties presented themselves. The classes were to consist of fifty Sisters just returned to the Mother house for a well-earned vacation, all of them tired from the strain of the classroom. How could I interest them and inspire them to do their best? Could these Sisters obtain sufficient knowledge to enable them to teach the science classes in their respective schools later on? The time allotted seemed inadequate, Educational Biology—five weeks, nine hours a week; Nature Study, three weeks, ten hours each week. Would this suffice to give a fair background to teachers who had little or no knowledge of science? Could it be done?

Planning the Work

The progressive teacher plans her work weeks and months ahead. Without a definite plan only haphazard results are to be expected. Under the circumstances, I had little time for extensive planning and preparation. Fortunately, my long experience gave me the necessary background to enable me to prepare quickly for the classes. But it did take considerable time and work to gather the materials to be used. Here are the materials we selected.

Materials Used

a. **Textbooks:** Since I do not believe that a teacher should follow any one textbook exclusively, I made a selection of the basic texts for developing worksheets and outlines. The textbooks were:

Textbook of Anatomy and Physiology	Kimber, Gray, Stackpole, 11 ed.
Physiology and Anatomy	Greisheimer
Human Body	Best and Taylor
Fundamentals of Physiology	Tokay
Mechanisms of the Body	Carlson and Johnson

b. **Models and Charts**

c. **Films**[1]

Second Week	*Third Week*
Muscles*	Digestive Tract*
Blood Vessels*	Foods & Nutrition*
Heart & Circulation*	Kidneys*
Breathing Mechanism*	Nervous System*
Story of Milk**	Eyes and Their Care
Story of Skin**	How We Hear*

Fourth Week	*Fifth Week*
Endocrine Glands*	Reproduction Among Mammals*
Heredity*	Reproduction in Higher Forms*
Man Against Microbes*	
Body Defense Against Disease*	
Fundamentals of Diet*	
Strange Hunger—Vitamins**	
Yesterday—Today—Tomorrow—Food Preservation**	

d. **Reference Books.** Most of these were procured from local libraries.

e. **Mimeographed copies** of 100-point Prognostic Tests.

f. **Mimeographed worksheets** for the following units:

Cells, Tissues, Organs	Excretory System
Skeletal System	Glandular System
Muscular System	Reproduction and Heredity
Digestive System and Nutrition	Nervous System and Senses
Circulatory and Respiratory Systems	Evolution

g. **Turtox Quiz Sheets:** Human Skeleton, Human Eye, Circulatory System, Heart and Lungs, Human Skin, Types of Animal Cells, Spinal Cord and Nerves, Human Ear, Median Head Section.

h. A special lecture was planned.

Nature Study Class

a. **Mimeographed sheets** of various outlines.

b. **Mounted Specimens:** Animals, Birds, Amphibians, Insects, Reptiles, Shells, Corals and Minerals.

c. **Turtox Sheets** for study and tests:

Fern Life History	House Fly
Beneficial and Harmful Insects	Seeds and Fruits
Honeybee	Flower Types
	Bird Adaptations

d. **Films and Filmstrips:**

First Week	*Second Week*
Spiders*	Camouflage*
Insects of Pond*	Water Animals*
Bee* Fly*	Life Under South Seas*
Beetles*	Carnivora*
Life of an Ant****	
Monarch Butterfly****	

Third Week	*Fourth Week—Extra*
Flowers at Work*	Rodents*
Wild Flowers*	Seed Dispersal*
Green Harvest—Trees**	Plant and Animal Reactions*
Birds of E. United States*	New and Old World Monkeys*
Animal Neighbors*	Shell Fishing*
How Animals and Plants Cause Disease*	Gift of the Green—Plants**
Animal Creatures of the Past*	Bees*** Earthworms***
Wheels Across Africa—Wild Animals**	George Carver*

e. **Mimeographed copies** of identification keys:

Mimeographed Keys

Key of Maple Trees	Key of Bird Nesting Habitats
Key of Summer Trees	Key of Amphibians

Purchased Keys — Catalog Numbers[2]

Leaf Key	C001	Fish Key	C039
Evergreens	C020	Birds	C002
Twigs	C036	Amphibians and Reptiles	C040
Moss Key	C071		
Ferns	C003	Land Insects	C043
Flower	C004	Aquatic Insects	C041
Bird Family	C073	Gall Insects	C042
Atlantic Shells	C044	Pacific Shells	C045

f. **Reference Material:** Books, Pictures, Charts.

For this group also, a special lecture was planned. Field trips, including a visit to Carnegie Museum and Phipps Conservatory were undertaken.

Carrying Out the Plan

Physiology. The class in Physiology met in the afternoon in order to give those Sisters who were taking other courses during the summer session an opportunity to audit it. The auditors attended the showings of films intended for the Nature Study Classes as well. On the first day, the 100 point prognostic test was given. This served as a starting point for the teacher and also gave the students a fair estimate of what was expected of them. These papers were corrected, but were not returned to the students until the end of the course when the test was repeated and the results compared.

Because of the time factor some of the units had to be covered during one class period; others were spread over several periods. Obviously, detailed study of each unit could not be carried out. As a preparation for each day's work, students were given daily work sheets which outlined definitely the new vocabulary for each lesson and listed the questions to be prepared for the next class period. The students were kept busy making sketches and drawings and printing labels. The first assignments for sketches and drawings were discouraging, but with a little patience and some explanation of the essentials, such as proper spacing, lettering, labelling, etc., exceptionally good work was eventually accomplished. This experience proved that the teacher will get what she demands if she is patient and persistent. Students invariably respond to suggestions when they see good results.

Films and Film Strips. Each day a film or a film strip was shown to illustrate some particular phase of the unit to be studied. To forestall any inclination to yield to traditional after dinner drowsiness, the films were shown at the beginning of each class period. These instructional aids aroused interest and helped to make the complicated processes of certain bodily activities more easily understood. Many of the films were procured through the Department of Visualization of the Public Schools of Pittsburgh.

Reference Books. A good collection of valuable reference material was made available through the courtesy of the Duquesne University Library and the South Side Branch of the Carnegie Library. These, together with several copies of the various textbooks listed, were placed on the bookshelves for use by the members of the class. This solved our book problem.

Mimeographed Sheets. Special mimeographed sheets with complete notes for the units on Reproduction, the Nervous System, and Evolution were distributed to the class. These were prepared by the teacher herself because she felt that the usual textbook material in these subjects would be confusing. The notes were used for study and as reference material for working the assignments on these units.

Quizzes and Tests. Regular quizzes were given using the Turtox Sheets for anatomy and the objective type tests prepared by the teacher for physiology. The semester tests were made to cover all the work of the units as well as the drawings.

Lectures. Near the end of the course Dr. Alfred Halpern of Duquesne University gave a lecture on "Drugs and the Nervous System." I wondered if the students would understand and be able to follow the lecture. Anyone who has ever taught the autonomic system with its antagonistic functions, and the various theories explaining their functioning, knows how confusing it is even to persons working in the field. Here was a class whose only contact with the subject of the nervous system was during three lecture periods. The reader may draw his own conclusions from the following reactions. "Only those well versed in the subject could appreciate this," was the frustrated comment of the visitors in the audience. The reaction of the students was different. With a look of satisfaction, they observed, "We understood every word of the lecture."

Nature Study. This class met in the morning. We found it easier to concentrate when our minds were fresh and the temperature comfortable. We tried in this course to complement the course in physiology and give the class a background of the plant and animal kingdoms. But could we cover the work in three weeks?

I decided that the best way to give the class a general idea of these kingdoms was to follow the Linneaus Classification. The lectures were supplemented by talks which the members of the class prepared on assigned topics. Extra credit was given to the member who was able to illustrate her topic with pictures, film strips, or actual museum specimens. These reports gave the teacher an idea how much study and preparation went into the assignment.

Goals Set. We set ourselves a definite goal as to the number of animals and plants we would learn to recognize during the course. The following list will give an idea of the scope of this work:

- 20 Birds of Pennsylvania—Permanent residents
- 40 Trees Common to Streets and Yards of Pennsylvania
- 25 Wild Flowers and a few common Weeds
- 20 Beneficial Insects
- 20 Harmful Insects
- 20 Mammals
- 3 Poisonous Snakes of Pennsylvania

a. In the study of birds we tried to cover their migration routes, their winter homes and nesting habits. Special charts helped in this study. We also observed birds in the open and studied their calls with the help of special records of bird calls.

b. We identified trees by using the simple Maple Key. When these were mastered, we attempted the identification of other trees. Special leaflets helped in the study of leaves.

(Continued on Page 26)

NEW BOOKS

Science at War

• *By* J. G. CROWTHER and R. WHIDDINGTON, New York: Philosophical Library, Inc. 1948. Pp. 185. $6.00.

Now it can be told, and a good job of telling is done by the authors based on information assembled by the Scientific Advisory Committee of the British Cabinet.

The book is divided into four parts, namely, Radar, Operational Research, the Atomic Bomb and Science and the Sea. The history of the development of these in Britain, the part British scientists played in their development and a simplified technical description of their operation are portrayed. Numerous charts, diagrams and pictures make the information more easily understood and more interesting.

J. A. Zapotocky

Human Biochemistry

• *By* ISRAEL S. KLEINER. C. V. Mosby Company. St. Louis, Mo., 2nd Edition, 1948. Pp. 649. $7.00.

The second edition of Kleiner's "Human Biochemistry" is a text revised in keeping with the advances of biochemistry and the allied sciences. The revision has also corrected the typographical errors of the first edition. This book is a more readable text.

A notable addition is the chapter on Chemical Structure in Relation to Biological Phenomena, and the section on "detoxification" which was lacking in the first edition. Professor Kleiner's research activity in the field of biochemistry is of great advantage in the selection of recent advances. It is of greater importance when the problem of deleting material arises. The omission of the "Carbonic Anhydrase Theory of Gastric HCl Formation" is in accord with modern biochemical theory.

The book is well written, in a clear understandable style. The glossy paper may be considered a limitation, for the glare of the reflected light made long periods of reading difficult for the reviewer.

Alfred Halpern

Poetic Art

• *By* PAUL CLAUDEL. New York: Philosophical Library. 1948. Pp. 150. $2.75.

People who know Paul Claudel only as the source of the powerful yet fragile beauty of *L'Annonce Faite a Marie*, will find a new man in *Poetic Art*. Those who are inclined to brush aside this work as another of those perennial redactions of Horace's *Ars Poetica* and Boileau's *D'Art Poeticque* will be greatly surprised. It says little about art and almost nothing about poetry. Rather, it plunges head-long into an impressionistic type of Neo-Scholasticism that sometimes causes the brain to reel.

Claudel busies himself with the old stock-in-trade of the Schoolmen—cause, necessity, time, space, motion, sense perception, intellection—but with profound differences. By his own word, "these pages are meant to be the beginning of a text on forests, the arborescent enunciation by June of a new Art of Poetry of the Universe, of a new Logic. The old one used syllogisms as an instrument of expression, the new one uses metaphor . . ."

There are times when this radical departure from traditional modes of expression becomes deliberately shocking: "So let skeptics talk on, how great is the security of knowledge! Indeed, together with us, the world exists; of course, it exists, since it is that which is not." (p. 93). Out of its context this looks like gibberish. In its setting, however, it is typical of Claudel's full-tilt assault on ideas that have grown rigid with the crystallization of centuries. He grabs them by the scruff of the neck and shakes them back into life.

The professional philosopher will groan and grimace as he turns the pages of this book, but he should not shirk the task. It is hard to say whether he will find it a cold shower or a vapor bath. No matter; both are good for the mind as well as the body.

Rev. Vernon F. Gallagher, C.S.Sp.
Vice President, Duquesne University

Art and Faith

• *By* JACQUES MARITAIN and JEAN COCTEAU. New York: Philosophical Library. 1948. Pp. 138. $2.75.

This is not a book for the impatient reader. Between its covers repose (or should we say, oscillate) two lengthy epistles: The first addressed by the modern French poet, Jean Cocteau, to the philosopher, Jacques Maritain; the second, Maritain's dutiful reply. It is obvious that both men wrote with an eye cast back over their shoulders at the reading public. In fact, their consciousness of the reader's presence is so great that they find it necessary to supply generous foot-notes and end-notes to their more recherché passages. These together with frequent explanatory notes appended by the translator, give one the impression that he must arm himself with an array of bookmarks before he can conquer this little volume

Cocteau, a prodigal son who owes his conversion to Maritain, is a stimulating but annoying writer. His letter abounds in personal references to modern artists like Milhaud, Stravinsky and Picasso, and his own style is often as chaotic and undisciplined as modern art at its worst. The translator, for whom the work appears to have begun as a labor of love, ultimately heaves himself out of his chair and screams: "Pass me the aspirin." (See note p. 36).

The fleurs du mal of Beaudelaire and Rimbaud mix their oppressive scent with the more wholesome fragrance of Plato and Augustine in Cocteau's letter. His Platonism appears again and again: "Poetry is just the country accent of heaven." (p. 20). ". . . what convinces the undecided intelligence is the skeleton of our religion, its figures, its algebra of love." (p. 54). "To resort to dreams is not to leave home; it is searching the attic where our childhood made contact with poetry." (p. 54). There are echoes of Schopenhauer as well as

of Plato in Cocteau's preoccupation with the perspicacity of childhood (p. 14-16) and there are occasional brilliant observations of his own: "Now the sincere man is not believed, and since he never contradicts himself, since he maneuvers without difficulty, he passes for a skillful player."

Maritain's letter is somewhat more staid and coherent. In his admirable attempt to be all things to all men, however, he seems to abandon dialectic rigor and play with the fire of Cocteau's emotional intuitiveness. The role does not suit him well. He discusses poetry and sanctity; the life of art and the life of grace; and speaks of the spiritual renaissance toward which the world is looking. He talks like a philosopher turned artist and the dichotomy is sometimes too great for even his Gallic clarity to bridge

All in all, *Art and Faith* is a challenging little couplet of essays. But for its preciosity it might have been a great book. Cocteau seems aware of this when he resolves to "endure without shame the smile of Theologians if (the book) will only stimulate a few young Catholics." (p. 59). He forestalls the opposition, however, by anticipating its condemnation by "boobs with horn-rimmed glasses." (p. 60).

Nevertheless, pass the horn-rimmed glasses, please.

Rev. Vernon F. Gallagher, C.S.Sp.

Introduction to Organic and Biological Chemistry

• *By* L. E. ARNOW and H. C. REITZ. 2nd Edition. C. V. Mosby Co., St. Louis, Mo., 1949. Pp. 795. \$5.75.

This text attempts to cover the important phases of organic chemistry and biological chemistry for premedical, predental, agricultural, home-economics and dietetics students. The rather wide scope of the interests of the students for whom this book is intended precludes a more detailed examination of subjects of particular interest. The book adequately covers the highlights of organic and biological chemistry and would serve as a useful text for a course with that intent.

The authors have included much new material in an effort to make the book serve its special purpose. The addition of study questions at the end of each chapter is a practice that authors of scientific textbooks consider an aid to the student.

Alfred Halpern

Radar Primer

• *By* J. L. HORNUNG. New York: McGraw-Hill Book Co., Inc. 1948. Pp. VI + 218. \$2.80.

This book discusses a highly technical topic in a manner that can be understood by laymen or by high school students, but it is not superficial. It was written by a specialist, now supervisor of radio-electronics at Walter Hervey Junior College, and formerly officer-in-charge of the Naval Training School (Radar) at Massachusetts Institute of Technology. An interesting approach is employed, describing first how radar operates at an airport, then studying separate phases such as the determination of distance and direction, and the visual representation on cathode ray tubes.

The applications of radar in peacetime are stressed, for air and sea navigation, as an altimeter or telemeter, and as direction and position finder (Loran). There is a brief description of the application of microwaves in television. The non-mathematical treatment, the questions and the review exercises and the bibliography make the book especially suitable for high school use.

Lucio Vallese

Physics for the New Age

• *By* ROBERT H. CARLETON and HARRY H. WILLIAMS. Philadelphia: J. B. Lippincott Co. 1947. Pp. 656. \$2.80.

Unusually attractive in format and content and a fine example of good modern bookmaking, *Physics for the New Age*, is a lot of book for little money. Planned for high school students, it provides a fundamental knowledge that will serve as a basis for further study and covers topics that will be of practical benefit to pupils who use the book in a terminal course. A successful attempt has been made to incorporate the advantages of the traditional physics course with a "life situation" approach that arouses interest and stimulates self activity. The numerous line drawings are fresh and new, the type selection good, the photographs unhackneyed. There are five color plates. A teacher's manual is available. *A. K.*

Physics for Arts and Sciences

• *By* L. GRANT HECTOR, HERBERT S. LEIN, and CLIFFORD E. SCOUTEN. Philadelphia, Pa.: The Blakiston Company. Pp. 731. \$5.50.

College students who are not science majors often find difficulty in mastering the usual first course in physics chiefly because of the mathematics involved. Here is a good beginning text which will stimulate such students and not distress them by a highly mathematical approach. Its subject material is up-to-date, and well arranged. Explanations are couched in simple language, involved sentence structures are avoided. Good use is made of color in line drawings. Heat and temperature, the behavior of sound, and other molecular phenomena are included under mechanics. Light is shown to be electrical in nature but geometrical optics associated with practical applications are also given. The book makes use of a number of features usually found in secondary-school textbooks, such as chapter previews and summaries, generalizations, questions and problems, and experimental problems.

The Arts and Sciences student who studies physics for background information, or who needs a knowledge of the science as preparation for a vocation will welcome this book. *A. K.*

★ ★ ★ ★ ★

It is my conviction that the church-related and other privately controlled colleges have a vital, an important and a permanent place in our plans and programs for higher education for American democracy; that the maintenance of their place and the effectiveness of their service depend wholly on the wisdom, the vision, the devotion and the generosity of those who believe in them, who determine their policies and who foster them; and that no external threat, real or imagined, can destroy them if vision, wisdom, devotion and generosity can in full measure be brought to bear upon their problems.

GOODRICH C. WHITE
President, Emory University
Association of American Colleges Bulletin
December '48

Summer Classes

(Continued from Page 22)

c. Wild flowers are abundant on our grounds and with the help of simple flower keys we were able to identify many of them.

d. The study of insects is a fascinating subject, but very few women seem to think so. Here was a class of such women that had to be made to handle and study those "obnoxious bugs." We began with the social insects, the bees, wasps and ants. Dr. Peter Gray, head of the biology department of the University of Pittsburgh, came to our assistance by giving an informative and interesting talk on "The Community Life of the Parasol Ants of South America." This lecture made such an impression on the class that many forgot their fear and spent their free time watching red ants raid the nests of black ants, from which they take the pupa into captivity to raise them as workers for their own colonies. Progress of this battle was reported with the same enthusiasm as if the observers were watching a football game.

Projects. During the second half of the course, the class was encouraged to prepare actual material they could use later in their class work.

Some of the things worked on were: preparation of small aquaria; mounting insect specimens; collecting spiders and preserving them in alcohol; collecting flowers and preparing herbariums; lists with places of procurement of films, museum specimens, identification keys, charts, free available material; bibliographies for future reference.

Trips. A day was set aside for a visit to Phipps Conservatory and Carnegie Museum where lectures were given to the group and the habitat of many animals and plants studied. The students had a rare treat when Dr. Walter Sweadner, curator of the entomology department, took them through his department and showed them some rare specimens of butterflies and moths that were worth hundreds of dollars each.

Proof of Interest. Can you imagine two Sisters catching a bat? They not only caught it but skinned it, prepared the skin and mounted it for the school museum. Teachers do get more than they ask for; here was proof. We admired the ambition of several teachers who decided to take jars of tropical fish, snails and aquaria plants to far distant cities. We wondered how they managed to keep the jars upright on shaky trains and not too smoothly driven taxicabs. Interest as well as materials was being carried home.

Difficulties

Some 15 members of the class made up their minds by the end of the first week that the teacher was talking "Greek," and they wanted to drop the course. Lack of confidence in their ability seemed to be their trouble; so the teacher had to challenge them in order to develop confidence in themselves. The challenge was accepted. They decided to try a week longer. Failure was averted and self-confidence engendered to such a point that by the end of the period this group ranked in the upper level of the class. Teachers must do more than just teach. They must keep the class working at its highest capacity. A little psychology and a bit of human kindness with discouraged students, often avert failure.

Of course, enthusiastic response cannot be expected at all times. Occasionally, some of the students slackened their pace. The road was too rugged. Pep talks were needed! It was even necessary to spur lagging interest by appealing to the feminine instincts of "getting a bargain." How was this done? By convincing the students that what knowledge they were now acquiring was but a small portion of what they should know as teachers. Once the class realized this, no further arguments were needed to stimulate them to get all they could from the present courses.

To the teacher herself, success lay in the realization that the summer's work gave her students deeper interest in science and opened to them the broad expanse of scientific study and research which would enable them to understand better the mysteries of Nature.

Through many digressions into the fields of pedagogy, psychology, mental and emotional hygiene, she tried to tie up their present study with the actual classroom experiences, and the probable reactions on their own lives and that of their pupils as balanced individuals.

Aftermath

A direct result of the summer's activities was the formation of a Nature Club to keep the Sisters informed about new material and to encourage the exchange of ideas. We plan to mimeograph a small circular for this purpose. The members hope to meet each summer and continue study in the special fields in which they have become interested.

Success may be attributed to the willing cooperation of each member of the class. It was a joy to see the progress made and the interest aroused in the rest of the Community who were exposed to the course incidentally while at recreation, at dinner table, or at the movies at which they were welcome visitors.

The teacher considers herself amply rewarded in the assurance that she was able to instill a love of nature in each teacher's heart which she in turn would relay to her pupils. It is in the power of the science teacher to bring God very close to the individual. Every blade of grass, every intricate mechanism of an insect, the synchronic activity of the human body, each points to the omnipotence of a Creator. Each specimen of nature portrays the beauty and wisdom of a loving Father who provides for each creature all the necessities to continue its life and fulfill the designs of its Maker. As a true Franciscan, a follower of the great lover of Nature, St. Francis of Assisi, it was a duty of the writer to carry this message to her class. We had many a meditation while we worked in class and many more as we roamed the fields and parks of our grounds. It left an imprint of the supernatural on each one of us—for we found sermons in flowers and bees; in birds and insects; in trees and the green under our feet. ●

SOURCES OF MATERIAL

1. Sources of Films:
   * Visualization Department of the Public Schools
   ** Modern Talking Picture Service INC.
   *** Courtesy of Mr. M. Ference, Duquesne University
   **** Ordered from Visual Arts Films Distributors
2. Purchased from Slingerland-Comstock, Ithaca, N. Y.

The Role of Comets

(Continued from Page 2)

boulders, which move around the sun, and become visible as luminous streaks when they enter the earth's atmosphere. A conspicuous shower of meteors appears each year about August 12 radiating from the constellation Perseus. In 1866, the Italian astronomer Schiaparelli (best known for his discovery of the Martian canals) found that the Perseid meteors were travelling in the same orbit as a comet observed in 1862. Today about a dozen different meteor showers have been found to be associated with comets. These facts point strongly to the conclusion that the meteors are products of the disintegration of the comets. The nucleus of a comet is therefore probably a compact swarm of meteoric particles visible by reflected sunlight. It is now possible to give a physical interpretation of the development of a comet. When the comet approaches the sun and is warmed by it, gases are released from the nucleus to form the coma. Some of these gases are driven away by the pressure of sunlight, and by other yet unidentified forces, to form the tail which points away from the sun. The matter which streams out into the tail is evidently lost to the comet, never to return.

Sometimes this process of disintegration is slow. Halley's comet has been observed on 29 returns since 240 B. C., but it has not declined appreciably in size or brightness. However, there are a number of recorded cases of rapid decay. Noteworthy is the comet discovered by Biela in 1826, which was found to have a period of 6.6 years, and to be identical with comets observed in 1772 and 1815. Found again on its return in 1832, it was too near the sun in the sky in 1839 to be picked up. During its next apparition in 1846, Biela's comet was seen to divide into two parts, which were seen again in 1852. Proximity to the sun prevented observations at the next return in 1859. The comet was very favorably placed in 1865, but despite extensive search no trace of it could be found, and it has never been seen since. Great meteor showers in 1872 and 1885 were recognizable debris of Biela's comet, as these meteors were found to travel in the same orbit as the comet.

More puzzling is the case of Holmes' comet. This was discovered as a conspicuous naked eye object on November 6, 1892, near the Andromeda Nebula. The comet was then receding from the earth and sun, and, if it had been a normal comet, would have been so very bright during the preceding months that it could not have escaped detection. Evidently the comet must have undergone a large and sudden increase in brightness just before discovery. During the next two months the comet faded rapidly, and became a large faint patch barely distinguishable in large telescopes. At

this point a remarkable change occurred. Barnard, observing the comet on January 16, 1893, was startled to find that its appearance had changed to that of an eighth magnitude star which, as he watched, brightened and grew in size from hour to hour. In the next few weeks, the comet again became a large faint glow, which faded till it was last seen on April 6.

The orbit of Holmes' comet was found to be an ellipse, and the next return in 1899 was eagerly awaited. In 1899 the comet was very faint, attaining at brightest magnitude 13, and in 1906 was excessively faint. Holmes' comet has never been seen since that year, and its remarkable changes in brightness and appearance remain unexplained.

There is a similarity between the phenomena undergone by Holmes' comet and the striking changes shown by a faint comet discovered by the German astronomers Schwassmann and Wachmann in 1925. Its orbit is very unusual for a comet, as it is nearly circular, and is contained between the orbits of Jupiter and Saturn. Thus it can be observed every year, although its period is 16.3 years. Ordinarily it is exceedingly faint, but from time to time will brighten for a week or two until it becomes visible in a small telescope and then slowly fades back to its usual faintness during the next month or so. A striking instance occurred early in 1946, when the comet brightened from magnitude 18 to reach magnitude 9.4, an increase of nearly 2000 fold in brightness, on January 26. On that day its spectrum was photographed by Herbig at the Lick Observatory, and disconcertingly was found to be merely reflected sunlight, without any evidence of the conspicuous bright lines which could have been expected from such an explosive outburst.

The phenomenon of the decay and disappearance of comets has an interesting bearing on their origin. Why is it that comets are still so very numerous despite their rapid disintegration? This suggests that the formation of the comets must be cosmogonically recent, and that perhaps they are even now being formed. By what processes this could occur is unknown, and indeed very little progress has yet been made toward understanding the origin of the comets.

We have thus seen that comets present many unsolved problems. It is noteworthy that while in recent decades the frontiers of astronomical research have been pushed far out into the realm of the stars and nebulae, there yet remain many little-known territories much closer home. No great comet has appeared under favorable circumstances since 1910. Since then there have been very great advances in spectroscopic, photometric and photographic techniques, and in the theoretical interpretation of observations made by them. The appearance of the next great comet will give a long-awaited opportunity to apply efficiently these new and powerful methods. ●

FOR READING

For nontechnical books on comets see Watson *Between the Planets* (Blakiston, 1941), and Olivier *Comets* (Williams and Wilkens, 1930). Each month reports of current comet discoveries and observations are published in *Popular Astronomy* and in *Publications of the Astronomical Society of the Pacific*.

A.A.A.S.

(Continued from Page 9)

of the first half century of its existence, the Association's headquarters were located in the offices of its successive secretaries. In 1907, space was generously provided in the Smithsonian Institution where the Association conducted its affairs until August, 1946, when, with the contributions of its members and many friends, it purchased an entire block in central Washington, adjacent to Scott Circle on Massachusetts Avenue. There are five old residences on the new site, one of which (1515 Massachusetts Avenue, N.W.) now houses the staffs of the A.A.A.S. and the American Psychological Association. The opportunity, therefore, is unfolding for the development of a great new scientific center to serve independent scientific and educational organizations. Such a Science Center will bring about marked economies in operations and greatly facilitate cooperation among scientists in many diverse fields. In this and in other projects, the Association is striving to meet its obligations and to prepare for the future by broadening and increasing its services to mankind. ●

★ ★ ★ ★ ★

Two Beginnings

(Continued from Page 20)

group of young people from a number of colleges (16 were represented at the last meeting in Washington). There are several occasions to meet informally, exchange ideas and make new acquaintances. This feature alone is almost without parallel in science education and offers the young scientists a fine opportunity which might not be available in any other way.

Perhaps even more important than this is the fact that the meetings are held in conjunction with the A.A.A.S. (The 1948 meeting because of the earlier Centennial meeting of the A.A.A.S. was held in conjunction with four science-teaching organizations.) Attending the general and sectional sessions of the A.A.A.S. gives these young people a first opportunity to see professional scientists in action at a time when research comes to blossom in the presentation of papers and reports. At these meetings the junior scientists have the occasion to see, meet, and talk with scientists whose work they know, whose books they have studied and who to some extent are the embodiment of what they desire to become. But this is more than a "hero worship" setup. The young scientists who attend the sectional meetings find themselves accepted in a kindred adult science group. They hear papers presented, questions asked and comments offered. They ask questions on their own. They find, to their joy, that there is nothing forbidding or exalting about the men who rank high in their chosen field. They find they can distinguish a good piece of research when they hear it reported. They often find their youth and interest pave the way for a friendly greeting or even a longer conversation with older scientists, and that scientists and science teachers are interested in their point of view.

The Junior Scientists Assembly has worked out very well. The younger participants who have attended the meetings have all felt that this was the beginning of adult participation in their life work. For all adolescents, the problem of being accepted and finding a place in the adult world is no easy matter. There are uncertainties and conflicts. The problem may be exaggerated for the young scientist whose intellectual interests and technical abilities have brought him to the adult level at an early age. In creating one way for young scientists to see an important phase of science in action and in participating in an important scientific convocation, the Assembly has done a fine job and has challenging potentialities for the further development of a whole series of related activities.

That there are two distinct beginnings to the scientist—a beginning of his science interest, often at an early age, and a beginning of this professional participation does not at all imply that these events are unrelated. The committee on the Junior Scientists Assembly had no advanced knowledge of the participants in each meeting. Selection of the invited group and panel speakers was worked out locally. Yet brief information obtained from these young people of three geographic areas, each on the verge of professional participation in science indicated their science interests and experiences

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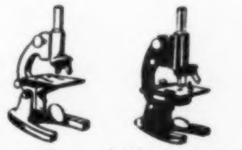

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had followed the typical pattern previously described. This information came from questionnaires filled in by all those who were invited.

Members of the first Assembly at Boston had become interested in science at ages between 6 and 15. Average, 10.5 years. They had done a great deal of voluntary science work when still young: constructed telescopes; made microscope slides; built model planes; collected minerals and insects, etc. The participants in the Washington meeting became interested in science between the ages of 5 and 14—average age 10.3. In addition, at both meetings several people, without mentioning a specific age, indicated that they had become interested at "a very early age," or said "I've always been interested in science." These Washington participants also engaged in similar activities on a voluntary basis. The data on the first three Assemblies, though limited in extent, are being summarized as one further contribution to our growing picture of science interests of adolescents and their significance.

The science-interested pupil deserves the attention of all science teachers. The satisfaction of working with these pupils, and their responses are ample repayment for the extra time and attention they demand. And when the science interest has developed, as it often does with the growing adolescent, till both are on the threshold of maturity, then the Junior Scientists Assembly and similar experiences can fill their proper roles. Teachers of science may take further interest in this, if they keep another fact in mind. While none of the youngsters who says he wants to be a scientist indicates he wants to teach science, that, in the long run, is what many will be doing. Wasn't it true in your case? It was in mine. ●

Joseph Priestley

(Continued from Page 14)

1804 and 1808, was in operation as late as 1827, or possibly 1831, and its remaining assets passed to the local school district in 1864[9].

Park[23] has described the extensive land purchases by Priestley, his son (Joseph Priestley, Jr.), and their associates, on the North Branch of the Susquehanna River and in the Loyalsock Valley, and the abortive plan to found on this land a pantisocratic colony, among whose members were to have been the English Romantic poets, Samuel Taylor Coleridge and Robert Southey.

The grave of Priestley is at Northumberland. His remains originally were interred in the Friends' Burying Ground or Quaker Green, and were removed to their present resting place in Riverview Cemetery several years prior to 1873. His home at Northumberland has been preserved, and is now the property of the Pennsylvania State College. Upon its grounds has been erected a museum for Priestleyana[9].

A proposal that the centennial of the discovery of oxygen by Priestley be celebrated on August 1, 1874 was made by H. Carrington Bolton[19] of Columbia College (now Columbia University) in April, 1874. The celebration was sponsored by the New York Lyceum of Natural History and held at Northumberland on July 31 and August 1, 1874 [20, 21]. Pennsylvanians played an important part in the celebration. The location was suggested by Rachel L. Bodley, then professor of chemistry in and dean of the Woman's Medical College of Pennsylvania. The initial contact with the citizens of Sunbury and Northumberland was made by Henry Wurtz[22], who was born in Easton, Pa. He was then a consulting chemist in New York City and Hoboken, N. J. The secretary of the centennial was Albert R. Leeds who was an honor graduate of the Central High School of Philadelphia and was then professor of chemistry in the original faculty of the Stevens Institute of Technology. Among the speakers were David Taggart of Northumberland and Henry Coppee, then president of Lehigh University. During the celebration, Persifor Frazer, Jr., professor of chemistry in the University of Pennsylvania, "proposed the formation of a chemical society." This proposal bore fruit with the organization of the American Chemical Society in New York City on April 6, 1876, and its subsequent incorporation. ●

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Perfumes and Flavors

(Continued from Page 16)

wood oils; dill and erigeron oils; peppermint and pennyroyal oils, and many other oils both costly and common are produced on American farms and in American forests and orchards. The pure natural onion oil that this essential oil house sells contains, in one ounce, all the flavor and odor of 250 pounds of onions from American farms. American red pepper is more than a match for imported capsicum in flavoring value; and American vetivert, lemongrass, sage and others are usually more desired than the imported oils. There are wormseed and hops, orange and lemon and grapefruit oils, hemlock and juniper and a host of others from our own soil.

Perfumed and flavored products will continue to play an ever-increasing role in our daily activities. We can look forward to such innovations as odors to coincide with the action, locale and theme of scenes portrayed on the silver screen. Undoubtedly new and interesting flavors will be developed which in themselves are duplicates of tropical fruits as yet unfamiliar to American palates. One can never tell when the imaginative minds of the flavor and perfume chemists will develop new demands in industries now in the embryonic stage that will in the future cater to Mr. and Mrs. America. ●

Understanding of Science

(Continued from Page 4)

similar to neon, an alternative consideration presented itself. Perhaps neon existed in the form of two types of atoms with different weight. Aston[5] undertook the task of testing this possibility by resorting to methods of separation. The first was by submitting neon to about 3000 fractionations over charcoal cooled by liquid air, and measuring the densities of the fractions with a quartz microbalance, but no appreciable separation was effected. Another attempt by diffusion was made, and after much tedious and laborious work, light and heavy fractions were obtained which had preceptibly different densities. Nevertheless, even with this result and positive ray evidence to indicate the presence of neon isotopes, Aston believed that none of these lines of reasoning carried absolute conviction of so important a conclusion.[6]

The work was interrupted by World War I, and by the time Aston was ready to attack the problem again in 1919, he had realized that separation relying on the slight difference in ordinary physical properties of the supposed isotopes of neon would be a failure. Still, Thomson's parabola method, while good enough for general mass analysis, was not a method of precision which could give a conclusive answer concerning the homogeneity of neon atoms. Accordingly, Aston devel-

oped a new instrument, the mass spectrograph, which was designed so that the effect of electrical and magnetic fields on charged atoms was such as to be able to separate quantitatively the suspected isotopes of neon. The instrument was successful, proving without a doubt that neon is composed of a mixture of isotopes of mass 20.00 and 22.00. This was in 1919. In the following decade one after another of the elements was subjected to isotopic analysis, both by Aston and Dempster, and isotopism among all the elements was shown to be the rule rather than the exception.

This final chapter in establishing the existence of isotopes affords an example of new techniques as a factor in the advance of science. It is certain that the discovery of isotopes among the lighter elements would have been delayed if it were not for mass ray analysis. Another thing which can be emphasized is the cautious manner in which the findings of this powerful technique were accepted, and the necessity for improving the apparatus to bring precision to the point where a quantitative conclusion could be drawn. The difficulties of experimentation are again in evidence. Aston failed to get a decisive separation of neon isotopes, not because of an impossibility, but only because of the difficulties involved. It is to be noted that about twenty years elapsed before Hertz[7] announced significant success in separating neon isotopes by diffusion. Perhaps the most important lesson to be learned is the example of the development of science by the vindication of a prediction and the modification of a theory. Crookes' prophecy came true. With few exceptions elements are composed of atoms of different weight; and thus one of Dalton's postulates, after a long survival, fell before the growing wave of scientific expansion.

To recapitulate, an attempt has been made to show how the historical approach to the study of isotopes may be used for the purpose of imparting some understanding of the development of science. In conclusion, nothing better can be done to impress the necessity of beginning this task wherever possible, than to sound the warning of Dean French[1]: "The stakes are higher than we think. Unless we attack the problem now . . . we may find science becoming the whipping-boy of an otherwise intelligent public, a public bound to fear — and distrust — that which it does not understand. Such a result could retard the progress of science and through it society in a measure which all the training of potential scientists could not hope to balance." ●

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Low-Temperature Spectroscopy Of Biochemical Substances

Scientists are unravelling mysteries of chemical substances important to biological processes by studying them at extremely low temperatures which slow down molecular motion.

A low-temperature research project conducted under a grant from the American Cancer Society was described recently by Dr. John R. Loofbourow, Professor of Biophysics at Massachusetts Institute of Technology, who spoke in Detroit before the thirty-third annual meeting of the Optical Society of America.

By reducing chemical compounds to a temperature near absolute zero, details of complex molecules hitherto unobservable can be studied by spectroscopic methods, he said. The research throws new light on cell division and growth and also on substances affecting living organisms, and it therefore leads to a better understanding of the processes that take place in living systems, both in normal functioning and disease.

"The solution of many of the fundamental problems of biology and medicine depends on finding out the exact nature of the chemical substances involved in biological processes. Thus, the isolation and identification of various vitamins and hormones has led to great advances in nutrition and the control of disease. Many chemical compounds of interest in biology and medicine are exceedingly complex. Optical methods, especially such techniques as absorption spectroscopy, are often of great use in the investigation of their structure. The usual methods of ultraviolet and visible absorption spectroscopy do not, however, yield as detailed information as desired for exact studies of many biochemically important substances.

"At room temperatures, various physical factors arising from the heat motion of molecules would be expected to result in loss of detail in the information obtainable by absorption spectra. This circumstance suggested the possibility of obtaining more detailed information about chemical molecules by applying spectroscopic methods at low temperatures.

"The increased spectral detail thus obtained at low temperatures is of use not only in unravelling mysteries of structure in biochemically important substances but also in identifying such substances when they are intermixed with other compounds of similar structure."

The research was conducted jointly by Dr. Loofbourow, Dr. R. L. Sinsheimer, and Dr. J. E. Scott, all of Massachusetts Institute of Technology.

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In an age in which methods of communication are such that bad news from every quarter pounds upon our sensibilities almost hourly, we must doggedly determine to limit to a bare minimum the acceptance of hearsay evidence. We must forego the emotional satisfaction of letting our sympathies be swept away either by the evils which surround us or proposals for Utopias which rain upon us from every side. A man must endeavor to be a rational human being without becoming a dehumanized intellectual machine. A deep concern for the welfare of humanity, a desire to participate in a struggle for a better world can be coupled with a skeptical approach to many matters. Easy solution for hard problems must be tested in the light of history and an accurate knowledge of current situations. To the extent that a university today can develop a critical attitude in its students and fortify their idealism and their courage, it will have succeeded in its task.

JAMES B. CONANT
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